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Cameron Engineers, Inc, Denver, Colo

Prepared for

Environmental Protection Agency, Denver, Colo Region VIII

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OIL SHALE RESEARCH OVERVIEW

MAY 1977

REVIEW REPORT

ENVIRONMENTAL PROTECTION AGENCY

ROCKY MOUNTAIN PRAIRIE REGION

DENVER, COLORADO

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16. ABSTRACT
This paper is a compilation of some federally sponsored oil shale research, both current and recently completed. It lists 148 programs, funding levels, descriptions, and project contact names.

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OIL SHALE RESEARCH OVERVIEW

by

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68-01-4337

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Prepared For
EPA Oil Shale Workgroup
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PREFACE

This report has been reviewed by EPA, Region VIII, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for us.

This report is envisioned as a working document. Comments from the reader are welcomed and invited for use in revisions and updates. Please send comments to:

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I. INTRODUCTION

The EPA intra-agency Oil Shale Workgroup was organized in 1974 in order to ensure coordination of all EPA oil shale environmental research programs. An outgrowth of this objective has been the communication and interaction with a multitude of local, state, and federal agencies; the oil shale industry; universities; and the public. In order to inform those persons interested in and knowledgeable of oil shale development and related environmental research, an attempt has been made to compile a listing of oil shale research programs.

This precis is intended to provide an overview of the oil shale research, both current and recently completed. It does not pretend to address all federally sponsored research, but it does provide an indication of areas of emphasis. Likewise, some of the funding levels shown are estimates or approximations and are, therefore, indicators of relative cost of research and development. The total funding level cited in this paper is $36,777,191.

A breakdown of funding levels and number of projects in the areas of 1) general environmental research, 2) water research, 3) atmospheric research, 4) land and revegetation research, 5) health effects research, and 6) miscellaneous oil shale research is shown in Table 1. Sections II through VII provide the interested reader with information on the funding level, purpose, and principal contact for projects identified in the six general categroies listed previously.

TABLE 1

AREA OF RESEARCH	NUMBER OF PROJECTS	FUNDING LEVEL CITED
General	18	$ 5,448,704
Water	34	3,678,157
Atmospheric	21	2,733,052
Land and Revegetation	7	1,535,170
Health	26	3,803,000
Miscellaneous	42	19,579,108
TOTAL	148	$36,777,191

II. GENERAL ENVIRONMENTAL RESEARCH

This section lists ongoing and completed research that focuses on more than one element of the environment. The level of funding of projects cited in this section amounts to $5,448,704.

EPA, NSF, ERDA, FEA - Characterization of Contaminants in Oil Shale Residuals and the Potential for their Management to Meet Environmental Quality Standards

Determine the amount and kind of organic components in carbonaceous spent shale and the effects of these components on regional environmental quality. The research includes an investigation of the potential effects on regional environmental quality of solubilization and leaching by ground and runoff water, volatilization of potential air pollutants, contaminants present in airborne carbonaceous particulate matter from oil shale processing operations and compounds formed by auto-oxidation of organic compounds volatilized from the waste and its subsequent transfer into air. A final report is due in spring, 1977.

Denver Research Institute
Josef J. Schmidt-Collerus
2199 S. University Blvd
Denver, Colorado 80210
(303) 753-1964

****

EPA/USDA - Assessment of Impacts of Mining and Airborne Pollutants on Forest, Range, and Related Freshwater Ecosystems

$583,000

Coordinated studies by Forest Service research scientists are underway at several locations in the Northern Great Plains and Southwest USA, conducted by: Director, Rocky Mountain Forest and Range Experiment Station, 240 West Prospect Street, Fort Collins, Colorado 80521; Director, Intermountain Forest and Range Experiment Station, 507 25th Street, Ogden, Utah 84401; Director, Forest Environment Research Staff, 12th and Independence Avenue SW, Washington, D. C. 20250. The work will (1) assess quality of water in water bodies in strip-mined areas as it relates to habitat for aquatic organisms and wildlife species associated with these water bodies; (2) assess technologies for redepositing and stabilizing mine spoils to include identification of technologies that will keep water quality within acceptable limits for aquatic organisms and associated wildlife species; (3) assess effects

of mining-related transportation systems on water, air, soil, plant, animal, and esthetic resources; and (4) develop an operational technical information system for reclamation of lands affected by mining. Completion date: 1979.

R. Z. Calaham - USDA

Forest Environmental Research
Forest Service
12th and Independence Avenue SW
Washington, D. C. 20250

****

EPA - Yellow Jacket Project

$25,000 This project is an aquatic terrestrial ecosystem study on the White River. Since 1961, the Bureau of Reclamation - Upper Colorado Region has been studying the feasibility of different water supply plans for a 4,000 square mile area in northwestern Colorado known as the Yellow Jacket Conservation District. This conservation district encompasses the White River drainage basin within Colorado and the adjacent Milk Creek drainage. Portions of the Piceance Creek basin area's oil shale formation and the Danforth Hills bituminous coal deposits lie within its boundaries. The Yellow Jacket project is a potential source of water for oil shale development, being designated to provide water for municipal, industrial, domestic, and agricultural uses. A progress report was issued in April 1976 and amended in November 1976. If this plan is eventually adopted, its projected cost, including interest during a five-year construction period, would be $96,820,000 (basis: January 1976 dollars).

Terry Thoem - EPA, Region VII, (303) 837-5914

U.S. Bureau of Reclamation
Western Colorado Project Office
P. O. Box 1728
Grand Junction, Colorado 81501

****

EPA - Identification of Components of Energy-Related Wastes and Effluents

$144,000 The long term objective of the proposed research is to identify substances in wastes and effluents from energy-related processes. Information developed from this program will assist researchers who are concerned with control technology and monitoring techniques and the health and

ecological effects of such energy-related pollution. The proposed work is divided into three phases. Phase A consists of a state-of-the-art summary and work planning which constitutes contacting EPA personnel to determine which energy-related solid waste and aqueous effluents have been analyzed for the purpose of identifying and measuring pollutants and which current contracts and projects will provide further identification. It will also consist of judging the reliability of existing information and the probability of accumulation of adequate data from current contracts and projects using pre-selected criteria. This information will be collated and summarized in a report for EPA. The report will identify gaps in existing and probable future data on chemical elements and volatile organic compound in solid wastes and aqueous effluents from coal mines, oil refineries, oil-shale processors, coal-fired power plants, coal liquefaction and coal gasification plants. Phase B consists of selecting sampling sites based on the recommendations from the report prepared in Phase A. The specific aims of Phase C consist of: (a) development and setup of analytical protocol, (b) qualitative and quantitative analyses for elements and organics in aqueous and solid wastes from the selected energy-related processes, and (c) the interpretation and collation of data obtained. Completion date: February, 1977.

Ann L. Alford
EPA, Environmental Research Laboratory
College Station Road
Athens, Georgia 30601
(404) 546-3186

Research Triangle Institute
Dr. E. D. Pellizzari
P. O. Box 12194
Research Triangle Park, North Carolina 27709

****

EPA - Environmental Impact of Oil Shale Development

$460,000 (FY75)
$412,000 (FY76)
$193,000 (FY77)

The major objectives of this project include the acquisition of the necessary background data on the principal industrial shale recovery processes and U. S. shale resources, a comparative assessment of their environmental acceptability and an evaluation of technologies available for the control of air, water, and solid waste emissions. Shale oil production requires cheap, large-scale materials handling methods at all stages of mining, retorting, and retorted shale disposal; maximum heat economy in retorting and upgrading; and minimum

water and power consumption. A number of processing sequences are available, each with its own accompanying environmental impacts. The evaluation and assessment program involves six tasks: (1) Project Management, (2) Oil Shale and Recovery Process Characterization, (3) Engineering Analysis and Problem Definition, (4) Field Testing and Laboratory Analysis, (5) Environmental Evaluation, and (6) Evaluation of Existing Environmental Control Technology. This project will provide a basis for the establishment of rational design, management, and monitoring procedures to mitigate unavoidable adverse environmental impacts. The type and magnitude of these impacts should be determined prior to the development of a full-scale oil shale industry. Project duration is from May, 1975, to May, 1978.

Thomas Powers - Cincinnati, Ohio (513) 684-4402

TRW Environmental Engineering Division
J. E. Cotter, Principal Investigator
One Space Park
Redondo Beach, California 90278

Denver Research Institute
C. Prien
2199 S. University Blvd.
Denver, Colorado 80120

****

EPA - Cost Effectiveness Pollution Control Studies for Oil Shale Development Scenarios

$ 217,000 (FY77)

Contract has been undergoing renegotiation early in 1977.

TRW
One Space Park
Redondo Beach, California 90278

****

EPA - Program Support for Synthetic Fuels

$42,700

Determine environmental impacts from coal and oil shale development of synthetic fuels. Completion date: December, 1975.

Radian Corporation
8500 Shoel Creek Blvd.
Austin, Texas 75758

****

EPA - Technology Assessment of Western Energy Resource Development

$1,297,504 Develop environmental control policies and implementation strategies for mitigating the adverse impacts of western energy resource development. Completion date: June 30, 1978.

Steve Plotkin - EPA, ORD, Washington, D.C. (202) 755-0646

University of Oklahoma
Norman, Oklahoma 73069

****

EPA - Impacts of Synthetic Liquid Fuels Development

$280,000 To assess the impact of development of synthetic liquid fuels from oil shale. Resource requirements, net energy analysis, legal mechanisms for access to oil shale resources, financing of the industry, government incentive policies, local and national economic impacts, environmental impacts, air pollution control, water resources, water pollution control, population growth, and boom-town effects are studied. A final report was issued entitled "Impacts of Synthetic Fuel Development" EPA #600/7-76-004a and b.

William N. McCarthy - EPA, ORD, OEMI (202) 755-2737

Stanford Research Institute
Dr. Ed. Dickson
333 Ravenswood Ave.
Menlo Park, California 94025

****

EPA - Energy-Related Radiological Monitoring Quality Assurance

$102,800 The objectives are to develop and maintain a quality assurance program which continuously meets the needs of those laboratories having responsibility for radiation monitoring in the environs of nuclear reactors and nuclear and fossil fuel extraction and processing facilities. This includes the distribution of calibrated samples and reference materials, cross-check studies, instrument development, and the publication of instrument quality control procedures and pertinent guidelines. An ongoing radioactive standards calibration and distribution program and a laboratory intercomparison studies program have been in operation at EMSL-LV since 1972 and are continuing on schedule. However, monitoring of the exploration, development, and utilization of energy sources will require a continual and expanded need

for both naturally occurring and man-made radionuclides for use in the preparation of standard reference materials, standard reference samples, and intercomparison studies. Standard reference materials, calibrated samples, and guidelines required for the analysis of samples obtained by monitoring activities in the vicinity of nuclear facilities, fossil fuel extraction and utilization activities, and geothermal sites will continue to be made available. A "state-of-the-art" beta counting system has been designed, constructed, is operational and is in the final testing stages. Guidelines describing calibration and quality control procedures for radiation monitoring using gamma spectroscopy and liquid scintillation counting have been prepared. An IAG was negotiated with NBS for the production of 300 radium-228 standards and for studies to assure our continued traceability measurements to the NBS.

G. B. Morgan - EPA, EMSL, Las Vegas, Nevada (702) 736-2969

EPA, Environmental Monitoring and Support Laboratory
A. N. Jarvis, Quality Assurance Branch
P. O. Box 15027
Las Vegas, Nevada 89114

****

EPA - Potential Radioactive Pollutants Resulting from the Expanded Program: Quality Assurance Aspects

$49,700

The objective is to identify and document the potential radioactive pollutants that could result from the expanded program and for which quality assurance programs must be provided. The research approach is to gather data on conventional and nuclear energy system facilities and operations, on the radionuclides in conventional and nuclear fuels and the releases of these radionuclides to the environment; to examine the pathways of these radionuclides to human exposures; and to compute the potential amount of the various radionuclide releases and associated hazards for a few selected plausible alternative expanded energy programs. The energy systems for which radionuclide releases will be assessed, from resource extraction to final waste disposal, include coal, shale oil, geothermal, and various nuclear systems. The project duration is from January 16, 1976, to November 30, 1976.

Paul A. Jarvis - EPA, Washington, D.C. (202) 557-5076

Stanford Research Institute
Robert M. Rodden
333 Ravenswood Ave.
Menlo Park, California 94025

****

EPA - Program Support in Environmental Assessment and Control Technology Development for Advanced Fossil Fuels

$432,000

The overall objective of this project is to provide technical and administrative support to the EPA Office of Energy, Minerals and Industry in carrying out its responsibilities as lead agency for environmental research on energy processes. In particular, support is being given in the areas of environmental assessment and control technology development for advanced fossil fuels conversion techniques, including high and low BTU coal gasification, coal liquifaction, residual oil gasification, oil shale retorting and certain problems of oil refining. Specific objectives include maintaining and updating a document on environmental problems and research and development programs, producing and maintaining a system for describing R&D options and setting priorities among the options, providing administrative and technical support for the interagency Advanced Fossil Fuels Sector Group and various short term assignments, such as professional meeting reporting, review of research plans, and consultation on specific technical problems.

William N. McCarthy - EPA, Washington, D.C. (202) 755-2737

Cameron Engineers, Inc.
Thayer E. Masoner
1315 S. Clarkson
Denver, Colorado 80210
(303) 777-2525

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ERDA/(EPA pass-through funds to Oak Ridge National Lab) - 150-Ton Retort Simulated Power Plant Burn

$50,000

Approximately 2,000 gallons of oil produced from the Laramie Energy Research Center 150-ton retort are to be dried to remove the water and washed to remove ash, then shipped to the Pittsburgh Energy Research Center. Combustion tests in the 100-hp boiler will be conducted. Off-gas analyses for oxygen, carbon dioxide, carbon monoxide, nitrogen, sulfur dioxide, hydrocarbon, and total particulates will be made. The wash water will be analyzed at LERC. This wash water will possibly be used in a pilot scale water treatment plant. The oil has been dried and washed and shipped to PERC; the burn is expected spring, 1977.

Dr. Richard Poulson, Manager
Environmental Sciences
Laramie Energy Research Center
P. O. Box 3395
Laramie, WY 82071

Pittsburgh Energy Research Center
ERDA, Mr. Daniel Bienstock

****

ERDA - Analysis of the Environmental Control Technology for Oil Shale Development

$52,000 Assessment of program levels in oil shale control technology. Emphasis will be placed on overlapping areas of development. Completion date: September 30, 1977.

Charles Grua - ERDA, Division of Environmental Control Technology, Washington, D.C.

University of Utah
Noel Denevers
Department of Chemical Engineering
Salt Lake City, Utah 84112
(801) 581-6024

****

ERDA - Development of a Chemical, Stability, and Transport Model of Oil Shale Process Wastes in Soil

$50,000 The purpose of this study is to investigate and model the source, transport, and physical and chemical reactions, stability, and fate of oil shale process wastes. This includes overburden leachates, retort waste water, mine dewatering salines, and prerefining wastes. Batch and column studies will be used to measure the equilibrium and kinetic parameters which control the fate and transport of the oil shale wastes and leachates through typical soil systems of the oil shale regions. A computer simulation program will be developed to predict pollutant transport through these soils. Additionally, the study will include identification and characterization of power site chemical wastes and measurement techniques for the soil reaction model input parameters. Both kinetic and equilibrium reaction data will be obtained and used to expand the equilibrium model to account for nonequilibrium reactions. The reaction model will be verified using wastes typical of those generated by actual power plants with soil column studies. Further, the model will be useful in evaluating various disposal alternatives for these wastes. Completion date: June, 1980.

R. E. Franklin - ERDA, Biomedical & Environmental Research Division

Battelle Memorial Institute
Ecosystems, R. C. Routson
P. O. Box 999
Richland, Washington 99352

****

ERDA - Rock Springs Site 9 In Situ Environmental Studies

Off-gas analyses have been performed for particulate and gaseous composition. A ground water monitoring system has measured pre-operational, operational, and post-operational water quality levels. Trace elements are being analyzed in both the air and water quality samples. All of the field work has been completed. Most analyses have been completed, and a draft final report is being written. Scheduled completion date is April, 1977.

Dr. Richard Poulson, Manager, Environmental Sciences, LERC

ERDA, Larmie Energy Research Center
P. O. Box 3395
Laramie, Wyoming 82071

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USBM - Technical and Economic Study of an Underground Mining Rubbilization and In Situ Retorting System for Deep Oil Shale Deposits

$75,000 (FY74) — Identifies the full range of processing and environmental aspects of an in situ development. Final report has been issued.

$128,000 (FY75) — Steve Utter - USBM, Denver Federal Center, Lakewood, Colorado 80225

Fenix & Scisson, Inc.
P. O. Box 15609
Tulsa, Oklahoma 74115

****

NBS - Quality Assurance and Instrumentation in Air and Water Pollution Mining

$200,000* — In cooperation with the Environmental Protection Agency (EPA) and other government agencies, the National Bureau of Standards (NBS) is developing methodology and Standard Materials for measuring the environmental effects resulting from increased energy production. The NBS Analytical Chemistry Division is initiating research and development

in the areas of reference materials, instrumentation, and methods required for monitoring air and water quality associated with energy production. The research and development leading to Standard Reference Materials (SRM), instrumentation and methods are urgently needed for the monitoring of air and water quality associated with increased energy development of many different types. Due to the current and future energy problems facing the U.S., it has become imperative for the rapid development of the internal energy capabilities of this country. In order to maintain an acceptable level of environmental pollution, the methods devised for increased utilization of these internal energy sources (e.g. petroleum, coal, uranium, geothermal) must be adequately evaluated and monitored for effects on air and water pollution. In order to effectively carry out its responsiblities in these areas, the EPA has requested the assistance of the NBS Analytical Chemistry Division for research and development of SRM's. The overall approach to be taken involves three (3) basic steps. First, in areas of well-defined pollution effects, the emphasis will be on the development and certification of SRM's to enable effective quantitation. Examples of such well defined pollution effects include gases in air pollution (e.g., sulfur dioxide, carbon monoxide) and trace metals in water pollution (e.g., mercury, arsenic, lead). Second, in areas of known effects but imperfect measurement methodology, research and development on analytical methods and instrumentation will be undertaken. Examples of these areas include particulates and trace organics in air and water pollution. Third, in areas of new or increased energy production techniques (i.e., coal gasification and liquefaction, uranium production, etc.), a series of workshops will be held to help define the current state-of-the-art, and future requirements for analytical Reference Materials and methodology for air and water pollution measurements. Appropriate Interagency Agreements became effective on May 25, 1975. Projects have been initiated. A number of SRM's will be produced and certified. Investigations into the relevant raw materials, products and residues from the various energy systems will be made. A series of workshops on the energy production processes and their pollution potential will be held to determine SRM's required. Completion date: June, 1979.

*Total funding is $715,000

Jerry R. McNesby - NBS

National Bureau of Standards
D. A. Becker, Recycled Oil, IMR
Washington, D.C. 20234

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III. WATER RESEARCH

This section lists government research applied to water and its role in oil shale development. The total level of funding appearing in this section is $3,678,157.

EPA - Toxic Effects on the Aquatic Biota from Coal and Oil Shale Development

$ 40,000 — Provide predictive information with regard to potential toxicants to the aquatic environment resulting from coal and oil shale extraction and conversion. Completion date: June, 1978.

Don Mount - EPA, Duluth Lab

Colorado State University
NREL
Fort Collins, Colorado 80523

****

EPA - Water Quality Hydrology Affected by Oil Shale Development

$108,000 (FY75)
$ 50,396 (FY76)

The development of oil shale deposits as a viable energy source has the potential for significantly influencing the water quality hydrology of both the Upper and Lower Colorado River Basins. The specific objectives of this project are (1) to gather all available data pertinent to the present future assessment of the water quality hydrology in the oil shale regions of the Upper Basin, (2) to summarize these data toward the identification of deficiencies, and (3) to develop and verify procedures for quantitative assessment of water quality. Completion date: June 14, 1977

Eugene F. Harris - EPA, IERL-Cincinnati, (513) 684-4417

Dr. David B. McWhorter, Assistant Professor
Department of Agricultural Engineering
Colorado State University
Fort Collins, Colorado 80523

****

EPA - Groundwater Research Monitoring of Energy-Related Developments

$ 54,000 — The objective is to direct the research and monitor the progress of contracts under this program. Three groundwater

basins will be studied by applying theoretically developed monitoring strategies and the results developed into guidelines for monitoring groundwater quality. A contract has been signed with GE TEMPO for an oil shale mining and processing project in the Uinta Basin, Utah, and a strip coal mining area in the Powder River Basin.

EPA, Environmental Monitoring and Support Laboratory
Donald B. Gilmore and Leslie G. McMillion
P. O. Box 15027
Las Vegas, Nevada 89114
(702) 736-2969

****

EPA - Groundwater Basin Research Monitoring of Energy-Related Developments

$1,379,525 The objective of this project is the development of a groundwater monitoring model and strategy that will be applicable to any strip coal mining and oil shale mining and processing area. Two groundwater basins will be intensively studied by applying a theoretically developed monitoring strategy and the results developed into a guideline for monitoring groundwater quality in each of the areas. Approximately 60 percent of the effort will cover groundwater in the strip coal mining area on the east flank of the Powder River Basin where there is mine-mouth power generation and railroad export. There are proposed coal gasification and liquefaction projects as well as a pipeline slurry proposal. The remaining 40 percent of the effort will be in the Uinta Basin, Utah, around Tracts U-a and U-b where there is a proposed mining and processing project. Baseline data covering identification of all ongoing monitoring and relevant groundwater information is ongoing. A monitoring strategy is expected in the summer of 1977 with immediate implementation. Completion date: June, 1981.

Leslie G. McMillion - EPA, EMSL, Las Vegas, Nevada
(702) 736-2969

General Electric - TEMPO
Dr. Richard Tinlin
P. O. Drawer QQ
Santa Barbara, California 93102

****

EPA - Impacts of Oil Shale Development on Colorado Resources

$ 4,300 Identify the impact of oil shale development on water resources in western Colorado. Final report was issued in July, 1976.

Terry Thoem - EPA, Region VIII, (303) 837-5914

University of Wisconsin
Madison, Wisconsin

****

EPA/USGS - Surface Water Quality Monitoring in Western Colorado

$ 50,000

Gather surface water quality data at four locations on the White River, Parachute Creek, and Logan Wash, for a determination of water quality parameters. This project started in July, 1975, and is on-going.

Terry Thoem - EPA, Region VIII, (303) 837-5914

USGS, Colorado District Office
Water Resources Division
Denver Federal Center
Lakewood, Colorado 80225
(303) 234-5092

****

EPA - Complete and Report Small-Basin Nonpoint Source Water Quality Monitoring Technology Evaluation Study for Oil Shale Development Area Surface Water Drainage System

$ 75,000 (FY76)
$ 40,000 (FY77)

The objectives of this program are to test, validate, and describe optimal water quality monitoring procedures and techniques for quantitatively assessing the contribution of nonpoint source pollutants in a stream segment potentially impaired by oil shale developmental activities. Water quality sampling and measurement procedures consist of grab-sampling techniques, automatic pump-type samplers, and automated in situ electronic contact sensors. Various biological sampling techniques and procedures are also being tested to establish techniques most appropriate for given monitoring purposes in a specific waterway. This is an ongoing project involving the field testing of a prototype surface water quality monitoring design in the oil shale area of eastern Utah. A final report is scheduled to be prepared in June, 1977.

Wes L. Kinney - EPA, EMSL, Las Vegas, Nevada (702) 736-2969

EPA, Environmental Monitoring and Support Lab
P. O. Box 15027
Las Vegas, Nevada 89114

****

EPA - Test Nonpoint Source Monitoring Procedures Previously Developed in a Second and/or Expanded Application. Assess Applicability of Procedures to other Nonpoint Sources.

$ 30,000 (FY77)
$ 67,000 (FY78)

This task provides for continued field testing of the previously developed monitoring design in a different study area or for an expanded effort in the same river basin. Establishment of appropriate monitoring and measurement procedures in a variety of watershed drainage basins subjected to various categories of nonpoint pollutants is a high priority agency research need.

Wes L. Kinney - EPA, EMSL, Las Vegas, Nevada (702) 736-2969

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Las Vegas, Nevada 89114

****

EPA - Evaluate Application of Oil Shale-Related Nonpoint Source Monitoring Techniques to Other Nonpoint Source Monitoring Needs/Application

$ 10,000

The objective is to determine applicability of monitoring design previously applied on prototype nonpoint source oil shale water quality monitoring project to other watersheds and other categories of nonpoint source pollutants. A multiyear National Agency Strategy for the control of nonpoint source pollutants is currently under development. Before control measures can be effectively implemented a number of research needs will have to be satisfied to provide information which is currently lacking. A high Agency priority research need addresses the application of methodologies appropriate for characterization and quantification of water pollution problems produced by the various categories of nonpoint pollution sources. Included are establishment of methods for the identification of problem areas and the identification and quantification of pollutants from given sources within each category. Monitoring and measurement methods are currently available for application to nonpoint source pollution assessment and characterization, but attention must be directed to the establishment of procedures most appropriate for application to given monitoring situations and purposes. Interim report will be prepared in September, 1977.

Wes L. Kinney - EPA, EMSL, Las Vegas, Nevada (702) 736-2969

EPA, Environmental Monitoring and Support Laboratory
P. O. Box 15027
Las Vegas, Nevada 89114

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EPA - Development of Techniques for Remote Monitoring of Organic Pollution in Surface Waters

$ 49,800

The ultimate objective of this program is to develop an active airborne monitoring system capable of providing quantitative data on the organic pollutional load of surface waters. The principle employed is an extension of the laboratory technique of spectrofluorometry. A water sample is irradiated with ultraviolet (UV) light of a specific wavelength and intensity and the resultant fluorescence emission is then monitored using a monochromator-multichannel detector combination. The fluorescence signal arises from dissolved organic materials both man-made and natural in origin rather than from the water itself which does not fluoresce. However, the water molecule emits a Raman band which, for very dilute aqueous solutions of organics, has a constant amplitude for given intensity of excitation radiation. This water Raman emission band can therefore be conveniently employed as a built-in reference source with which to compare the amplitude of the concurrent fluorescence emission. The normalized amplitude of the signal then provides information concerning the concentration of the dissolved organics. A number of reports have been published recently which indicate that this UV induced fluorescence emission is proportional to the Total Organic Carbon (TOC) value. It is planned to explore this relationship in more detail with the purpose of establishing a firm value for a correlation coefficient. Based on the findings of this correlation study, an airborne laser-fluorosensor will be designed, built, and tested. This system will have the capability of continuously monitoring and recording the TOC value for the surface water below the aircraft. Project duration is from FY75 to FY78.

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Remote Monitoring Methods
Remote Sensing Division
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Las Vegas, Nevada 89114
(702) 736-2969

****

EPA - Energy-Related Water Monitoring Data Integration

$152,000

The objectives are to establish a water monitoring net throughout the western states to monitor and assess the impact of energy resource development. Through the use of computer data banks, primarily STORET, water monitoring

stations that are currently in operation, back past 1970, and have reported a large number of measured parameters were selected for incorporation into a primary monitoring net. Parameters of interest were identified and a quality assurance program is being established in participating laboratories. Historical data have been reviewed and baseline water quality conditions are being established. Preparation of a Western Energy Resources Atlas is being accomplished in conjunction with a similar effort on air monitoring. Data from the primary net stations are being augmented with data from other stations. An assessment of baseline water quality, trends, and impacts on a basin by basin basis is underway. As data gaps, either desired parameters, sampling frequency, or additional stations are identified, actions will be taken with appropriate EPA Regional Offices or other governmental agencies to correct them. The primary net will be updated periodically and extended into areas not presently addressed. Project duration is from FY75 to FY80.

Victor W. Lambou - EPA, EMSL, Las Vegas, Nevada

EPA, Environmental Monitoring and Support Laboratory
Robert Thomas
Water and Land Quality Branch
P. O. Box 15027
Las Vegas, Nevada 89114
(702) 736-2969

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EPA/ERDA - Instrumentation and Methods for Characterizing Aqueous Effluents from Oil Shale Sources

$ 60,000

Plans to develop a large scale oil shale processing technology in the Green River formation must include surveilance of related effluents. This project focuses on the development of methods for the chemical characterization of aqueous effluents associated with the retorting processes; attention is being given principally to organic and trace metal components. Organic components are being analyzed by several methods under development. First, major organic components are analyzed directly by gas chromatography with no sample pretreatment. Minor and trace organic components are removed from the samples by adsorption on activated carbon, neutral macroreticular resins and ion exchange resins. Profiling of components is carried out using gas chromatographic methods employing standard and specific element detectors. Fractionation of the organic mixture is followed by identification and quantification of some

nitrogenous bases. Trace metals will be determined simultaneously by spark source mass spectrometry. Samples of retort product water were obtained from the Laramie Energy Research Center. Activated carbon extraction is being carried out on this and other aqueous samples from a coal conversion process to gain some detailed knowledge of extraction efficiencies for compound classes using this technique. When the extraction procedure is sufficiently developed, instrumentation for automation of this step will be developed concomitantly with chemical characterization studies.

Hodge R. Wasson - ERDA

Oak Ridge National Laboratory
Bruce R. Clark
Analytical Chemistry Division
P. O. Box X
Oak Ridge, Tennessee 37830

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EPA/USGS - Development of Instrumentation and Techniques for Measuring Sediment-Laden Streams

$270,000 (FY75)
$195,000 (FY76)

The objectives of this project are to develop, test, and field evaluate flumes, weirs, and other devices and means suitable for measuring sediment and debris-laden flows, to develop an in situ instrumentation system capable of measuring the mass concentration of sediment in water, to develop an acceptable sampler(s) for measuring the discharge of bedload sediment particles so as to permit the effects of energy development, particularly mining activities, on streams to be monitored. Flumes, weirs, and other types of control structures are being developed, tested, and field evaluated in the areas of oil shale and coal mining. Photographic techniques are being investigated. A literature search will be made of commercially available suspended solids sensors compatible with the objective. One or two instruments will be selected for comprehensive laboratory tests. An automatic sampling and data-logging system to operate in conjunction with the optimum sensor will then be designed. The complete package will be tested first under simulated field conditions. Promising direct-measuring bedload samplers will be calibrated to define their efficiencies under various conditions. The effects of such things as particle size, transport rate, bed form, hydraulic condition, sampler orientation, and degree of filling on sampler efficiency will be ascertained. Appropriate samplers will be modified and/or new samplers developed and subsequently tested and calibrated to

provide improved operation. Experimental weirs and flumes have been installed on the Belle Fouche River in Wyoming, on Piceance Creek in Colorado, and on a tributary of the North Fork of the Kentucky River, Kentucky. The state of the art in photographic techniques that might be applied to the problem of flow measurement is being assessed. Although the equipment survey is only partially complete, a Dynatrol density gage is being tested. One of the bedload samplers of primary interest is the Helley-Smith sampler, which is a pressure-difference-type sampler that has been used recently by several investigators. Completion date: April, 1980.

P. E. Greeson - USGS, National Center (703) 860-6834

USGS, National Center
Arthur D. Scott
Water Resources Division (MS415)
Reston, Virginia 22092
(703) 860-6837

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EPA/USGS - Water Quality and Geochemistry of Shallow Aquifers of Piceance Creek, Colorado

$ 10,000

The objectives of the project are to collect detailed chemical analysis of the relatively shallow ground waters that may be impacted by mining for oil shale and associated minerals, principally in the Piceance and Yellow Creek basins of Colorado. The study serves to support a portion of an initial effort to improve predictive geohydrologic and chemical models that may better evaluate the impact of oil shale mining on the hydrologic regime of the Piceance basin. The total effort is designed to develop the data base and analytical capability required to make evaluations. The existing state of chemical equilibrium must be documented and studies of water quality made to predict effects of dewatering on water chemistry. Water samples will be collected from approximately 10 new wells and many springs located in the Piceance Creek basin. Chemical analyses for a broad suite of parameters will be conducted on selected samples. Chemical analyses of water from 10 wells and 48 springs were analyzed and are being used to identify the source and distribution of major and minor ionic species in the Green River Formation. The dissolution of Nahcolite ($NaHCO_3$) and the sources of fluoride, boron, lithium, and barium are of particular concern. A complete list of chemical constituents are given in the memorandum of agreement. Copies of the chemical analyses are sent to the U.S. Environmental

Protection Agency periodically. A quasi-three-dimensional solute transport model of the ground-water basin was constructed but could not be properly calibrated. The solute transport model indicates that the distribution of inter-aquifer flow calculated by a previous flow model produces about 10 times too much mass discharge to Yellow and Piceance Creeks. Data are being compiled and analyzed for use in constructing a profile-oriented solute transport model. Completion date: 1980.

F. A. Kilpatrick - USGS, National Center, Reston, Virginia
(703) 860-6846

USGS, Colorado District Office
Stanley F. Robson
Hydrologic Studies Section
Denver Federal Center
Lakewood, Colorado 80225
(303) 234-3815

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EPA/USGS - Potentiometric Surface of Shallow Aquifers in Piceance Creek Structural Basin

$296,000 (USGS)

$ 20,000 (EPA-VIII FY75)

Develop a calibrated digital model that can be used to predict the effect of oil shale development on the hydrologic system. This development will be accomplished through the drilling and completion of additional test wells. The data will be used to improve the calibration of an existing digital model of the system. Progress has included the preparation of drilling specifications and a contract award and the successful completion of 22 observation wells. The total footage drilled was 25,092 feet. Water temperature and specific conductance data, water samples for chemical analysis, and discharge rate measurements were obtained from each well. Bilmayers, Inc., of Kalispell, Montana, was awarded the contract for a low bid of $563,000. Contract drilling began in May 1975. A basic data report will be prepared in 1977 which will summarize the data collected during drilling of the observation wells.

Jack Weeks - USGS, Colorado District Office, (303) 234-5092

USGS, Colorado District Office
Water Resources Division
Denver Federal Center
Lakewood, Colorado 80225
(303) 234-3815

****

EPA/USGS - Surface Water Quality Monitoring in Energy Development Areas

$ 17,440 (FY75)
$ 19,700 (FY76)

The objective of this study is to collect water quality data in the oil shale and coal development areas of Utah. There are four existing USGS monitoring stations located in the oil shale and coal areas and these stations will be supplemented for additional parameter coverage. Along with the monitoring of physical-chemical parameters, a biological monitoring program will also be initiated. The total effort will aid in documenting the existing baseline water quality conditions in the oil shale and coal development areas so that possible future impacts can be evaluated. The USGS will be responsible for the collection and analysis of surface water quality data in energy impacted areas of Utah. Monthly samples are obtained at each of four gauging stations as follows: 1) Field measurements of temperature, specific conductance, pH, stream flow, dissolved oxygen, and alkalinity: monthly; 2) Chemical analyses of all major ions: monthly; 3) Nutrients: monthly; 4) Total organic carbon and dissolved organic carbon: monthly; 5) Total trace metals and dissolved trace metals: As, Al, Be, Cd, Cr, Cu, Fe, Pb, Li, Mn, Hg, Mo, Ni, Se, V, and Zn: quarterly; 6) Phytoplankton: monthly; 7) Periphyton: quarterly; and 8) Suspended sediment and turbidity: monthly. Completion date: April, 1980.

F. A. Kilpatrick - USGS, National Center, Reston, Virginia
(703) 860-6846

USGS, Water Resources Division
James C. Mandorff
8002 Federal Bldg.
125 So. State St.
Salt Lake City, Utah
(801) 524-5663

****

EPA/USGS - Water Quality Monitoring on White River, Parachute Creek, and Logan Wash in Oil Shale Areas of Western Colorado

$ 22,702 (FY75)
$ 25,800 (FY76)

The objective is to collect detailed water quality data from selected surface waters in the areas of western Colorado likely to be impacted by oil shale development. The study will initiate several new water quality monitoring stations and supplement the parameter coverage at several existing baseline water quality conditions in the oil shale area so that possible future impacts from oil shale development can be evaluated. There are two existing USGS monitoring stations located upstream and downstream from the Federal

oil shale leases on the White River; these stations will be supplemented for additional parameter coverage. The proposed Parachute Creek station will be established between two different oil shale projects and upstream from major irrigation diversions to provide baseline water quality data and monitor future impacts from oil shale development. The station proposed for Logan Wash will provide baseline data used to evaluate the water quality impacts of in situ oil shale development in that specific drainage. Stream flow water quality monitoring equipment for the Parachute Creek and Logan Wash stations has been acquired. Data collection and analysis for an extensive suite of parameters was initiated in August, 1975. Completion date: April, 1980.

F. A. Kilpatrick - USGS, National Center, Reston, Virginia
(703) 860-6846

USGS, Colorado District Office
Richard Grozier
Water Resources Division
Denver Federal Center
Lakewood, Colorado 80225
(303) 234-5092

****

EPA/USGS - Collection of Geochemical Data in the Piceance Creek Structural Basin of Colorado

The purpose of this project is the collection and analysis of geochemical data on the relatively shallow ground waters that may be impacted by the extraction of oil shale in the Piceance and Yellow Creek Basins of Colorado. Water samples will be collected from approximately 12 wells and many springs. Chemical analysis for approximately 30 parameters will be collected on selected samples. Data will be used to refine predictive models of resultant water quality both for those waters encountered by mining operations and Niok waters centering surface drainages and springs and seeps.

F. A. Kilpatrick - USGS

USGS, Colorado District Office
George Saulnizr
Water Resources Division
Denver Federal Center
Lakewood, Colorado 80225
(303) 234-3815

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USGS - Water Resource Reconnaissance in the Roan Plateau and Parachute Creek Areas

Study of availability and water quality of surface water resources in the Roan Plateau and Parachute Creek area.

Jack Weeks - USGS, Colorado District Office, (303) 234-5092

USGS, Colorado District Office
Water Resources Division
Denver Federal Center
Lakewood, Colorado 80225

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USGS - Sediment Yield of Streams in the Piceance Basin

Installation of 29 automatic sediment samplers to sample sediment on a periodic basis and to determine potential effects of surface mining operations on sediment yield.

Jack Weeks - USGS, Colorado District Office, (303) 234-5092

USGS, Colorado District Office
Water Resources Division
Denver Federal Center
Lakewood, Colorado 80225

****

USGS - Aquifer Testing in the Piceance Basin

Perform aquifer tests and collect limited aquifer test information to make further determinations with respect to the vertical permeability of the mahogany zone and leakage factors. Drill seven new observation wells.

Jack Weeks - USGS, Colorado District Office, (303) 234-5092

USGS, Colorado District Office
Water Resources Division
Denver Federal Center
Lakewood, Colorado 80225

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USGS - Hydraulic Research of Springs

Evaluation of the dewatering effects of oil shale development on approximately 90 springs. Project includes

definition of extant geology, upper/lower/perched aquifers, and definition of faulting systems. A report is due in 1977.

Jack Weeks - USGS, Colorado District Office, (303) 234-5092

State of Colorado
Denver, Colorado 80203

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USGS - Sorption of Residual Organic Substances in Retort Waters by Spent Shale Residues

$ 40,000

The various oil shale retorting processes produce 10-50 gallons of waste retort water per barrel of oil. This retort water contains 3,000-5,000 mg/l of dissolved organic substances. At present, retort water is disposed on spent oil shale residues. Organic solutes may leach into groundwater or run off into surface water if the sorptive capacity of spent oil shale residues is exceeded. Because the sorptive capacity of spent oil shale residues for residual organic substances in retort waters is unknown, there are no recommendations pertaining to the disposal capacity of spent oil shale organic substances in retort waters. A preliminary objective is to develop an organic water quality analytical program such that background concentrations of dissolved and sediment organic materials can be determined and characterized for surface and groundwater in regions of oil shale and coal development. The overall objective is to determine the capacity of spent oil shale residues to adsorb and immobilize residual organic substances in retort waters. The sorptive capacities of the soils and sediments which underlie and which may be spread upon spent oil shale residues will also be determined. Organic solutes in natural surface and groundwater in regions of oil shale and coal development and organic solutes in retort waters will be characterized with respect to surface area, permeability, porosity, elemental and mineralogical composition, functional group composition and saturating ions. Adsorption isotherms will be determined for retort water organic solutes on oil shale, soil, and sediment adsorbents. Adsorption kinetics will also be studied to determine adsorption mechanisms.

Jerry A. Leenheer - USGS, Colorado District Office

USGS, Colorado District Office
Water Resources Division
Denver Federal Center
Lakewood, Colorado 80225

****

USGS - Definition of Potentiometric Surface of Shallow Aquifers in Piceance Creek Impacted by Oil Shale

$ 20,000 Describe the detailed steady-state conditions of the groundwater system of the Piceance Creek basin prior to mining for oil shale. Drilling of wells is 55 percent complete. Completion date: January, 1976.

F. A. Kilpatrick - USGS

USGS, Colorado District Office
Hydrologic Studies Section
Denver Federal Center
Lakewood, Colorado 80225

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USGS - Water Quality and Geochemistry of Shallow Aquifers of the Uinta Basin

$ 20,000 Collect detailed chemical analysis of groundwaters that may be impacted by mining for oil shale in the Uinta Basin of Utah. Twelve wells have been sampled and analysis is complete. Completion date: April, 1980.

F. A. Kilpatrick, USGS

USGS, Water Resources Division
Salt Lake City, Utah

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USGS - Establishment of New Surface Water Quality Monitoring Stations in the Powder and Green Rivers of Wyoming

$ 69,970 Augment existing seven-station surface water quality monitoring study with the addition of 14 new stations in the Powder River coal and the Green River Basin in Wyoming. Expanded sampling on schedule. Completion date: April, 1980.

F. A. Kilpatrick, USGS

USGS, Water Resources Division
Cheyenne, Wyoming

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ERDA - Laboratory Determination of Leaching Rates from Oil Shale Retorted under Simulated In Situ Retorting Conditions

$ 63,320 This project is to gather selected laboratory data regarding the rates at which inorganic salts will be leached from

spent shale by water under conditions which may occur during and following in situ retorting of oil shale. Preliminary laboratory results show that the amount of leachable inorganic salts is highly dependent upon the temperature at which the shale was retorted. This situation occurred only when air was excluded from the retorting conditions. When air was allowed to burn the carbon from the shale, all retorting temperatures produced about the same amount of leachable inorganic salts.

ERDA - Fossil Energy Division - Oil, Gas, and Shale Technology

Texas Technological University
Lubbock, Texas 79409

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ERDA - Biological Degradation of the Soluble Organic Components in Retort Water

$ 51,367 The biological degradation of the soluble organics in the in situ-produced water is being studied by employing different bacteria strains. It is hoped that this approach will convert and disintegrate the organic components into carbon dioxide. Period of performance was from June 30, 1975 to June 29, 1976.

ERDA - Fossil Energy Division

University of Southern California
Los Angeles, California 90007

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ERDA - Instrumentation and Methods for Oil Shale-Related Effluents

$ 60,000 Develop method for chemical characterization of aqueous effluents associated with oil shale processing. Completion date: June, 1977.

ERDA, Division of Biomedical and Environmental Research

Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

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ERDA - Oil Shale and Tar Sand Effluent Characterization

Characterization of water effluents from oil shale processing.

Battelle Memorial Institute
Pacific Northwest Laboratory, Lou Rancitelli
P. O. Box 999
Richland, Washington 99352

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ERDA - Water Conservation with In Situ Oil Shale Development

$160,000 This project is to identify the geographical area within which water-related impacts resulting from in situ oil shale development may prove significant. Project will describe a typical in situ facility operating at 100,000 barrels per day. It will also describe the magnitude and geographical extent of an oil shale industry (i.e., one million barrels per day). It will also compile data describing existing water resources and their present use. It will describe major drainage basins, precipitation runoff, evaporation, water quality and hydrology of surface water resources, groundwater resources in the study area along with quality and hydrology, water use. The in situ technology will be defined; process effluent control technology will be shown for the promising in situ technologies. Water requirements will be defined. Effluent amounts and quality will be defined. Water impacts will be described for in situ development. Consideration will be given to spent shale disposal, upgradient facilities, sanitary facilities, evaporation from water storage reservoirs and dust control. Contamination of groundwater by flow through exhaustive retort chambers will be identified. Contamination of groundwater by leachate and spent shale disposal sites will be defined. Contamination of water resources (surface) by disposal of high TDS ground water from dewatering operations will be identified. Finally, contamination of surface waters by runoff will be identified. Alternatives to development and control technologies will be discussed. A water quality monitoring strategy for chemical, physical, and biological parameters will be defined. Quarterly reports are being issued.

Jerry Ramsey - ERDA, Division of Oil, Gas and Shale Technology, Washington, D.C. 20545

University of California
Professor Jerome F. Thomas, Civil Engineering Department
Berkeley, California 94720

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USDA - An RFF Forum on the Impact on Western Waters, Fish, and Wildlife on Energy Development

$ 75,000

Impact of western energy development on water resources and subsequent effect on fish and wildlife. Forum held in Albuquerque, New Mexico, in summer, 1976. Completion date: October, 1976.

Robert Hayden - U.S. Fish and Wildlife Service

Resources for the Future, Inc.
1755 Massachusetts Ave. NW
Washington, D.C.
(202) 462-4400

****

USBM - Water Management in Oil Shale Mining

$ 99,637

$ 30,000 (mod 1)

Project is assembling all available information relating to water management in oil shale development, analyzing water availability, water requirements, water loss and use, dewatering strategies, and water disposal associated with various oil shale development techniques. A compilation of all federal and state regulations and concerns is to be part of the study. Consideration is to be given to 50,000 and 100,000 tons per day mine capabilities. Underground room and pillar mining is to be concentrated on. Water treatment techniques in order to comply with state and federal regulations are to be designed. Recommendations for R&D work that would improve the planned water usage are to be included in the final report. Project was recently modified for the contractor to look at the in situ method of development. A final report is due in 1977.

Bill Stewart - USBM, Spokane, Washington

Golder Associates
Mr. Adrian Brown
Vancouver, British Columbia, Canada
(604) 879-9266

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NSF - An Assessment of Western Regional Water Supply and Demand Requirements for Synthetic Fuel Production

$ 84,200

This research will focus on an assessment of water resources and environmental constraints on the siting of fuel-to-fuel conversion complexes in the western states and will determine what level of synthetic fuel industry could be supported by

1990 in the easily and economically mined coal and oil shale regions in the West. These constraints may be, and in some areas of the country will be, the factors which limit the production of synthetic fuels. Specific areas for possible synthetic fuel plant complexes will be identified and the total number and distribution of these complexes will be selected. Determination will then be made of the locally available fresh and saline surface and groundwater supply sources and the ranges of the quality and quantity of water that are required for present and future agricultural, electric and nuclear power, industrial, municipal-domestic, and recreational uses. The water quality and quantity requirements for various fuel conversion processes, together with the effluent quantities will be available from results obtained under a previous grant. The results of the site specific assessment will be published in a widely distributed policy alternatives document suitable for decision makers and containing the technical background from which the various alternatives are presented. Contract duration is from March, 1976, to August, 1977.

NSF, Advanced Energy Research and Technology

Water Purification Associates, R. F. Probstein
238 Main Street
Cambridge, Massachusetts 02142

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IV. ATMOSPHERIC RESEARCH

This section lists research programs aimed at characterizing, measuring, and monitoring atmospheric effects. The level of government funding cited is $2,733,052.

EPA - Air Pollution Emissions from Oil Shale Conversion Facilities

$ 22,000 — A compilation of best set of emissions data from oil shale conversion facilities. The Paraho, Union, and TOSCO processes were investigated. Final report was issued spring, 1977.

Terry Thoem - EPA, Region VII (303) 837-5914

Radian Corporation
Austin, Texas

****

EPA - Air Quality

$ 30,000 (FY 76/77) — Measure particulate, sulfur dioxide, and nitrogen oxides at Rifle, Craig, and Meeker, Colorado. Data collection is on-going.

Terry Thoem - EPA, Region VIII (303) 837-5914

Colorado Department of Health
Air Quality Division
4210 East 11th Avenue
Denver, Colorado 80220
(303) 388-6111

****

EPA - Pilot Ballon Observations in Rocky Mountain Prairie Region

$ 75,000 — Collect temperature profile and wind speed/direction twice per day, every other day, near Tract C-b, Tract U-a/U-b, and Craig, Colorado. Project started March 1, 1976, and data collection is on-going.

Terry Thoem - EPA, Region VIII (303) 837-5914

Aeromet, Inc.
P. O. Box FF
Norman, Oklahoma 73069

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EPA - Smog Chamber Studies of Atmospheric Chemistry of Organic and Nitrogen-Containing Emissions from Emerging Energy Technologies

$ 50,000 Literature survey of emission rates of hydrocarbons, nitrogen oxides, etc., from shale oil production and coal mining; smog chamber study; and 21 field measurements at selected sites. Completion date: June 29, 1976.

Basil Dimitriades - EPA

EPA, Environmental Sciences Research Laboratory
Research Triangle Park, North Carolina 27711
(919) 549-8411

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EPA - Ambient Air Monitoring in Areas in the Vicinity of Energy-Related Sources/Western Energy Development

$325,000 Provide baseline air quality monitoring data and assessment reports for areas to be impacted by energy development. Completion date: December, 1980.

Dr. David N. McNelis - EPA

EPA, Environmental Monitoring and Support Laboratory
P. O. Box 15027
Las Vegas, Nevada 89114
(702) 736-2969

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EPA - Remote (Overhead) Research Monitoring of Energy-Related Developments

$140,000 Demonstrate effectiveness of overhead remote sensing. Completion date: 1980.

Albert E. Pressman - EPA

EPA, Environmental Monitoring and Support Laboratory
Remote Sensing Division
P. O. Box 15027
Las Vegas, Nevada 89114
(702) 736-2969

****

EPA - Investigation and Feasibility Study of Methods for the Identification and Measurement of Inorganic Compounds Emitted as Particulates from Sources Using or Processing Fossil Fuels

$ 70,000 Develop, evaluate, and test field methods for the identification and measurement of the amounts of inorganic compounds emitted from sources using or processing fossil fuels. Completion date: September, 1977.

Ken Knapp - EPA

EPA, Environmental Sciences Research Laboratory
Research Triangle Park, North Carolina 27711
(919) 549-8411

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EPA - Development of a Two Frequency Downlooking Airborne LIDAR System

$ 60,000 The objectives are to design, construct, and test a two frequency downward-looking airborne LIDAR system. LIDAR systems have demonstrated capability in solving several current pollution monitoring problems, namely, (1) determining mixing layer height over large geographical areas in short periods of time; (2) determining point source plume dimensions; and (3) determining the dimensions of and structure within an urban plume. The system design utilizes, whenever possible, off-the-shelf components including the laser transmitter. Much of the electronics control and readout subsystem is implemented using microprocessor systems thus shifting the construction burden from hardware to software. Much attention is given in the design to operator interaction including a real time display system for the data. The optical/mechanical design phase has been completed. Systems design work has been completed on the electronics portion of the device; however, actual implementation in hardware and software will commence after flight testing the optical system. The completed system will be operational by December, 1977.

EPA, Environmental Monitoring and Support Laboratory John A. Eckert, Remote Sensing Division
P. O. Box 15027
Las Vegas, Nevada 89114
(702) 736-2969

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EPA - Energy-Related Western/Southwestern Regional Air Monitoring

$786,500 This project provides integrated and validated air quality monitoring data (baseline and trend) and assessment reports for western areas of the U.S. which will be most seriously impacted by energy-related development activities. Emphasis is on fine particulates, nitrogen oxides, sulfur oxides, reactive hydrocarbons, toxic substances, and visibility. The geographical coverage includes the Northern Great Plains, the Four Corners area, oil shale areas of Colorado and Utah, the Black Mesa area of Arizona, and areas of New Mexico. Project duration is from FY 75 to FY 80.

EPA, Environmental Monitoring and Support Laboratory Dr. David N. McNelis, Monitoring Operations Division P. O. Box 15027
Las Vegas, Nevada 89114
(702) 736-2969

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EPA - Quality Assurance in Support of Energy-Related Air Monitoring in the Western United States

$222,000 The objectives of this program are the development and implementation of a quality assurance program associated with agencies carrying out air pollution monitoring around present and proposed sources of energy in the western United States. The program will be carried out by providing on-site system reviews of agency air monitoring operations, establishing and operating a performance survey program and providing technical assistance as required. A number of on-site system reviews have been conducted. The program duration is from July, 1976, to July, 1981.

Steven M. Bromberg - EPA, EMSL, RTP (919) 549-8411 X2196

Rockwell International
Dr. E. P. Parry
2421A West Hillcrest Drive
Newbury Park, California 91320

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EPA - Catalytic Desulfurization and Denitrogenation

$ 91,878

Catalytic hydrodesulfurization (HDS) and hydrodenitrogenation (HDN) reactions for the removal of organic sulfur and nitrogen compounds from liquid fuels are becoming increasingly important as strict sulfur and nitrogen oxide emission standards are set and "dirtier" oils derived from shale and coal attain wider use. A quantitative description of the interferences between these two reactions, which have only recently begun to be studied is necessary for optimal design of commercial processing units. To date, studies have been done on thiophene and pyridine as representative sulfur and nitrogen compounds in a continuous-flow microreactor to model basic interactions. Pyridine inhibits thiophene IIDS under all experimental conditions used. Sulfur compounds exhibit a dual effect on the HDN of pyridine; a reaction rate inhibition gives way to an enhancement at more severe reaction conditions. Theoretical considerations have been presented to account for each of these effects. Reactions of more complex compounds and their interactive reaction kinetics are currently under investigation. The duration of the project is from August, 1975, to August, 1978.

William J. Rhodes - EPA, IERL, RTP (919) 549-8411

Massachusetts Institute of Technology
Charles N. Satterfield, Professor of Chemical Engineering
Cambridge, Massachusetts 02139

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EPA - Perform a Literature Survey on Present Emissions from Various Stationary Sources and to Conduct Smog Chamber Studies of Emissions Found

$ 74,915

The increasing demand for energy in the face of shortages of available fuels has resulted in the emergence of new processes and technologies aimed at increasing the energy output from fossil fuels. As the requirement for energy increases, the impact of such processes on air quality must be evaluated. The operations for consideration are shale oil production, petroleum refining, and coal mining, combustion, and gasification. Conventional mobile and stationary combustion sources have been the major contributors to the photochemical pollution burden in many areas. Composition and emission rate information coupled with oxidant-forming potential from smog chamber investigations will enable EPA to assess the future impact of

new energy sources on air quality. The objectives of this investigation are (1) to perform a literature survey to gather information on composition and rates of emissions of organic, nitroxy, and sulfoxy emissions from various operations of the emerging energy technologies; and (2) to conduct smog chamber studies of the atmospheric chemistry of emissions from production and refining operations related to coal and oil-shale conversion and petroleum refining. Completion date: August 31, 1977.

Robert Farland - EPA, ERSL, RTP (919) 549-8411

Research Triangle Institute
Dr. J. E. Sickles, II, Environmental Measurements Department
P. O. Box 12194
Research Triangle Park, North Carolina 27709

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EPA - Evaluate the Impact on Ambient Air Quality of an Oil Shale Industry

$ 61,212 Environmental Research and Technology, Inc.
741 Lakefield Road
Westlake, California 91360

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EPA - Identification of Emissions from Gasoline Dervied from Coal and Shale Oil

$199,900 Southwest Research Institute
San Antonio, Texas

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EPA - Energy-Related Overhead Monitoring and Techniques Development

$142,000 The objective is to establish preliminary guidelines for and demonstration of overhead remote monitoring of western energy-related activities. A cooperative western energy-related overhead monitoring program between NASA and EPA has been established with the purpose to define, demonstrate, and develop operational remote sensor techniques to rapidly monitor, in a cost effective, quantitative manner, the success with which an energy-related extraction site has been, or is being, rehabilitated to a state suitable for its intended or previous land usage. This includes the determination of environmental baselines for the purpose of establishing rehabilitation criteria as well as environmental effects of mine-mouth power plants.

EPA, Environmental Monitoring and Support Laboratory
B. Edward Arthur, Jr., Remote Sensing Division
P. O. Box 15027
Las Vegas, Nevada 89114
(702) 736-2969

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EPA/NASA - Western Energy-Related Overhead Monitoring (WEROM)

$ 50,000*

The objective of this project is to transfer remote sensor data acquisition and processing techniques from NASA to EPA for energy-related overhead monitoring system. The project will be conducted in three phases with data from selected sites in the Western U.S. Of the total effort expended during the project, approximately 50 percent will be dedicated to the monitoring of coal strip mine rehabilitation activities. Monitoring the environmental impact of mine mouth fossil fuel power plant emissions will account for approximately 30 percent of the total effort. Rehabilitation problems associated with oil shale extraction will comprise about 15-20 percent of the project work ($50,000). Minor effort will include monitoring techniques applicable to geothermal propsects. During Phase I (18 months) coal strip mine monitoring products derived from satellite and aircraft data acquisition systems have been delivered to EPA for evaluation. In addition, a data-processing system has been assembled and will be transferred to EPA during Phase II. EPA personnel have been scheduled for a training course during which techniques dealing with the use of system hardware and NASA software and processing techniques will be presented. Phase II (18 months) will include demonstration and transfer of monitoring techniques developed during Phase I. The demonstration will consist of a periodic inventory of selected sites and will approach the operational system to be used by EPA. During Phase III (two years) EPA will use the techniques in an operational mode, with NASA providing assistance in the operation of the system, and in the addition of new capabilities as developed during Phase I and II. Project duration is from August, 1975, to December, 1979.

* Total estimated funding: $550,000.

W. Stoney - NASA, HQ, Washington, D. C. 20546

NASA, Earth Resources Laboratory
E. L. Tilton, III
1010 Gause Blvd.
Slidell, Louisiana 70548

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EPA/NOAA - Air Quality and Surface Wind Monitoring in Colorado

$ 15,714

Install and operate air monitoring sites in the energy areas of western Colorado to collect baseline data prior to major expansion of energy activities. Particulate samples from the energy area will be analyzed for nitrate and sulfate content.

Mr. Machta - NOAA

Colorado Department of Health
Wayne Max, Air Pollution Control Division
4210 East 11th Avenue
Denver, Colorado 80220
(303) 388-6111

Mesa College
Grand Junction, Colorado 81501

****

EPA/NOAA - Collection of Upper Air Data in the Fort Union Basin

$ 15,714

This study is a continuation of a contract that is providing upper air data at seven sites: Craig and C-b Oil Shale Tract, Colorado; Hanksville and Escalante, Utah; Casper and Rock Springs, Wyoming. Temperature, wind speed and direction versus altitude are being measured via pilot balloons and temperature sondes. Pilot balloons are released twice a day, every other day. Temperature and wind data are used to generate stability-wind rise data on a seasonal, annual, and monthly basis. Summaries of inversions and mixing-layer heights are also provided.

Mr. Machta - NOAA

Aeromet, Inc.
Dr. Ray Booker
P. O. Box FF
Norman, Oklahoma 73069

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NOAA - Meteorological Interpretation and Prediction of Air Quality in the Western United States Related to Energy Activities

$100,000 Take selected air quality measurements together with meteorological trajectory data and predict impact of future energy resource activities. Completion date: March 19, 1980.

John W. Townsend, Jr. - NOAA

NOAA, Air Resources Laboratory
Silver Spring, Maryland

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NOAA - LIDAR Techniques for Measuring Particulate Pollutants from Energy Production and their Transport and Dispersion Processes.

$150,000 Task I is application of Doppler LIDAR to monitor atmospheric processes that transport and disperse pollutants. Task II is to apply LIDAR techniques to measure particulates emitted from power generation facilities. Completion date: June 30, 1979.

John W. Townsen, Jr. - NOAA

NOAA, Environmental Research Laboratory
Wave Propagation Laboratory
325 Broadway
Boulder, Colorado 80301
(303) 499-1000

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USGS - Assessing the Impact of Oil Shale In Situ Development

$ 51,219 Assessment in northwest Colorado and northeast Utah region on the air quality.

Environmental Research Technology, Inc.
Westlake Village, California

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V. LAND AND REVEGETATION RESEARCH

The research cited in this section is focused on land use, shale spoils, and revegetation. The government funding cited is $1,535,170.

EPA - Vegetative Stabilization of Paraho Spent Oil Shale

$ 94,000 (FY75)
$ 33,393 (FY76)

The objective of this research is to study surface stability and water movement in and through Paraho spent oil shale and soil-covered Paraho spent shale. In addition to the vegetation studies, the distributions of water and salts in the plots will be monitored with the objective of quantifying the potential salt pollution from shale residues. Because it is not possible to experimentally model the actual prototype disposal, the data from the plots will be used to develop and verify a mathematical model of salt and water transport. This model will be used to estimate the long-term water quality and quantity aspects of large scale disposals of spent shale residue. The duration of this grant is from July 15, 1975, to July 14, 1978.

Eugene Harris, Extraction Technology Branch, IERL, Cincinnati (513) 684-4417

Colorado State University
Dr. William A. Berg
Department of Agronomy
Fort Collins, Colorado 80523
(303) 491-6483 or 491-6501

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EPA - Vegetative Stabilization of Spent Oil Shales

$ 15,000 (FY75)
$ 21,054 (FY76)

This study is being carried out on two different spent oil shales. "Soil" treatments are plant establishment: (1) directly on leached and fertilized spent shales; (2) on six inches of soil over leached spent shale; (3) on one foot of soil over unleached spent shale; and (4) on soil. Plots have been established on 25 percent north and south slopes at altitudes of 5700 and 7200 feet in or near the Piceance Basin of northwestern Colorado. Each plot (28 per site) is bordered with wood to form individual runoff plots 11 feet wide and 22 feet long. Sediment and runoff catchments have yet to be installed. One site (5700 feet) has been instrumented for soil salinity and soil moisture measurements. A cover of native plant species has been established on the lower altitude site and will be

established on the higher site. Measurements on vegetation include frequency, density, and vegetative ground cover. Completion date: August 31, 1977.

Eugene F. Harris - EPA, IERL, Cincinnati (513) 684-4417

Colorado State University
William A. Berg, Department of Agronomy
Fort Collins, Colorado 80523

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EPA/USDA - Technologies for Controlling Adverse Effects of Mining on Forest, Range, and Related Freshwater Ecosystems

$539,000 Coordinated studies by Forest Service research scientists underway at several locations in the Northern Great Plains and Southwest U.S.A. being conducted by: Director, Rocky Mountain Forest and Range Experiment Station, 240 West Prospect Street, Fort Collins, Colorado 80521, (303) 484-6270; Director, Intermountain Forest and Range Experiment Station, 507 25th Street, Ogden, Utah 84401, (801) 399-6361; Director, Forest Environment Research Staff, 12th and Independence Avenue, S.W., Washington, D.C. 20250, (703) 235-1071; and Director, Northeastern Forest and Range Experiment Station, 6816 Market Street, Upper Darby, Pennsylvania 19082, (215) 597-3715. The work will: (1) develop guidelines and criteria for overburden drilling, analysis, and placement as related to growth-supporting media; (2) prepare technical handbook on revegetation methods for mined lands in the eastern U.S., including recommendations for new research; (3) develop guidelines and criteria for the use of non-mine wastes as soil amendments on coal and oil shale spoils; and (4) develop recommendations, guidelines, and criteria, based on new research, for revegetation following coal and oil shale mining.

R. Z. Callaham - USDA, Forest Environment Research

U.S. Department of Agriculture
12th and Independence Avenue, S.W.
Washington, D.C. 20250

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ERDA - Spent Shale Revegetation

$250,000 Project is carrrying out spent shale revegetation of a variety of vegetation types at a location in Piceance Basin, Colorado.

Bob Kerr - ERDA, Laramie Energy Research Center

Colorado State University
Dr. Simms
Fort Collins, Colorado 80521

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USDA - Develop Criteria for Utilization of Irrigation to Ameliorate Adverse Site Conditions for Initial Plant Cover Establishment

$ 13,000 — Determine effectiveness of supplemental irrigation and the duration of its effectiveness after termination on establishment of vegetation in semi-arid areas. Location of the work is Sand Wash, Utah. Duration of project: June, 1973, to June, 1978.

Bryant Davis - U.S. Forest Service, SEAM, Billings, Montana

U.S. Forest Service
Intermountain Forest & Range Experiment Station,
Mr. Paul Packer
860 N. 12th E.
Logan, Utah

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USBM - Research Contract for the Underground Disposal of Spent Shale from Paraho Retorting Process

$304,123 — Cleveland Cliffs Iron Co.
Rifle, Colorado

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USGS - Northwest Colorado Oil Shale Environmental Geology

$265,600 — Bedrock and surficial basic geologic mapping derivative and interpretive environmental geologic aspect maps from basic data. Land capability maps and reports to aid persons charged with deciding land use, land restoration following mining, and constraints to land use by industry and individuals. Bedrock mapping has been completed in the Dinosaur National Monument area. Various quadrangle maps of Rio Blanco, Moffat, and Uintah Counties have been produced.

USGS
Mr. John Maberry, Program Manager
Energy Lands Program
Lakewood, Colorado 80225
(303) 234-4857

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VI. HEALTH EFFECTS

Considerable biological and medical research is being done to characterize health effects and transport processes. This section lists a government funding level of $3,803,000 in addition to $660,000 being spent by the American Petroleum Institute.

EPA - Influence of Combustion Effluents of Shale Oil Products on Induction of Pulmonary Cancer in Laboratory Animals

$250,000 In-house research to characterize and model effluents and study health effects. Anticipated completion date: 1981.

Dave Coffin - EPA

Health Effects Research Laboratory
Research Triangle Park, North Carolina 27711
(919) 549-8411

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EPA - Air, Water, and Multi-Route and Health Effects from Pollutants Associated with Energy Development

$ 25,000 Studies have been designed to assess the health effects of exposures to substances which pollute air and water as a result of energy technologies. Emphasis is being placed on potentially toxic agents resulting from fuel extraction, conversion and combustion. The evaluation of the toxicity of the pollutants and their metabolic products include a spectrum of bioeffect indices. The present program includes: (1) The assessment of exposure to toxic organic chemicals which are associated with energy processes and which reach man through water. The investigations include screening for potential carcinogens, mutagens, and teratogens in water supplies, as they result from energy sources emphasizing coal and shale oil processing. (2) Toxicologic data are obtained for multi-route exposures from metal pollutants resulting from fossil fuel extraction, combustion and conservation. The establishment of additional physiological and biochemical indicators to establish a more sensitive dose; effect data base includes studies of age sensitivity and influence of dietary composition on absorption, deposition, and toxicity of the trace elements which pollute the environment from energy-related sources; long-term effects of inhalation exposures to toxic components of fly ash;

biochemical effects of energy-related trace metals on pulmonary macromolecular metabolism. The project duration is from October 1, 1976, to October 1, 1977.

J. F. Stara - EPA, HERL, Cincinnati

EPA, Health Effects Research Laboratory
26 W. St. Claire Street
Cincinnati, Ohio 45268
(513) 684-7401

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EPA - Determination of the Effects of Material from Alternate Energy Sources on Upper Respiratory Trace Clearance Mechanisms

$ 30,000 (FY 75)
$ 40,000 (FY 76)

The objective of this contract is to screen a variety of substances for their toxic effect on mucociliary activity using an in vitro model system. Since cilia play a significant role in pulmonary clearance, proper functioning is essential for defense against various environmental insults. However, ozone, nitrogen dioxide, nickel, and cadmium have an adverse effect on this system Therefore, it becomes increasingly important to determine if alternate energy sources such as shale oil and coal gasification and liquefaction, or particulate effluents from power stations, stationary engines or mobile sources produce pollutants toxic to the mucociliary escalator. Due to the above considerations isolated hamster tracheal rings will be exposed to pollutants in vitro. Parameters to be measured are: (1) effect on ciliary beat frequency, (2) effect on the energy source (ATP) of beating, (3) effect on ciliary and tracheal morphology, and (4) recovery of the tracheal rings after exposure. In all cases, parameters will be tested for dose-response effects. Project duration is from October 1975, to May, 1979.

Dr. Donald E. Gardner - EPA, HERL, RTP (919) 549-8411

Ball State University
Dr. Dorothy Adalis
Department of Biology
Muncie, Indiana 47306

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EPA - Determination of the Influence of Mineral Cofactors in Conjunction with Carcinogens from Energy-Related Materials

$300,000 (FY 75)

The objective of this project is to determine the influence of environmental materials such as fibrous am-

$470,000 (FY 76)

phiboles, fine particles, etc., as cofactors with carcinogenesis influences from alternate energy sources such as coal gasification and liquefaction, and shale oil products and effluents. The methods employed would be intratracheal instillation and intrapleural innoculation. The end points would be formation of cancer in the lung or pleura or development of precancerous lesions compared to appropriate controls. The duration of this project is from December, 1975, to August, 1978.

David L. Coffin, D.V.M. - EPA, HERL, RTP (919) 549-8411 X2266

Northrop Services
Huntsville, Alabama

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EPA - Air, Water and Multi-Route Exposures and Their Effects: Pollutants Associated with Energy Development

Constituents of and compounds derived from petroleum hydrocarbons may accumulate in portions of the marine food chain consumed by man. The objective of this research is to provide an assessment of the potential for accumulation of specific carcinogens found in fractions of shale oil. Completion date: October, 1978.

EPA, Environmental Research Laboratory
Dr. Norman L. Richards
Sabine Island
Gulf Breeze, Florida 32561
(904) 932-5311

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EPA/NIOSH - Mortality, Morbidity, and Industrial Hygiene Study of Oil Shale Workers

$290,000

This project is a study of 444 men who have worked in pilot oil shale operations. The cohort will be divided into three smaller cohorts consisting of (1) 294 men from the U.S. Bureau of Mines and (2) 135 men of the Joint Venture of the Colorado School of Mines Research Institute and COLONY in Anvil Points, Colorado, and also (3) 15 men from the Union Oil Retort facility in Grand Valley, Colorado. A retrospective mortality study of approximately 60 men will be done in house while a cross-sectional morbidity examination to evaluate several morbidity aspects that may be associated with oil shale occupations will be done by contract. Mortality due to 21 specific

causes of death will be determined after an extensive follow-up effort and the obtaining of death certificates of those determined to be deceased. Observed deaths will be compared to those expected to uncover excess deaths due to a particular cause. Numerous indices of health will be assessed through the physical examinations and health questionnaires administered to the living members of the cohort. Further activities tentatively include environmental exposure and medical assessments of workers entering the industry. The Industrial Hygiene aspects of this study will be a joint U.S. and U.S.S.R. research project on the health effects associated with the oil shale industry. William Wagner will make an initial trip to the U.S.S.R. to develop joint U.S.-U.S.S.R. survey protocol. A Russian delegation headed by Dr. Gogovsky will then visit the U.S. for approximately three weeks in May 1977. The Environmental Investigations Branch will be responsible for the planning of this trip. Contact will be made with those people knowledgeable in oil shale technology, and those who are or have been involved in health studies related to oil shale, mining, and retorting. Three industrial hygienists from the EIB are tenatively scheduled to travel to the Soviet Union in September to perform walk-through surveys of U.S.S.R. oil shale operations. Completion date: November, 1978.

John F. Finklea, M.D. -NIOSH

NIOSH, Appalachian Laboratory for Environmental Safety and Health
Robert Reger, William G. Jones
944 Chestnut Ridge Road
Morgantown, West Virginia 26505
(304) 599-7501

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EPA/HEW - Compilation and Tabular Abstracting of Literature on Mutagenic Effects of Energy-Related Pollutants

$ 45,000

The tasks of the Environmental Mutagen Information Center (EMIC) will carry out are to compile the past and present literature on mutagenesis testing of energy-related pollutants. This information will then be processed into EMIC's data bank noting bibliographic details and key-wording of chemicals, organisms, and systems studied. Energy Information Files are now available at EMIC. They are: (1) Petroleum Refinery Stream Effluents - Select chemicals from effluents resulting from refinery streams were searched for potential mutagenic activity and "select" toxicity; (2) Toxicity of Coal Liquefaction Products represents limited search of general publications in EMIC - shale oil, oil shale, coal conversion,

and energy-related files for toxicological information. Coal conversion files are being maintained, and pertinent references are being selected and added for possible interest to the funding agencies of NIEHS.

Dr. Fred de Serres - NIEHS (HEW)

National Institute of Environmental Health Sciences
Dr. H. V. Malling, Environmental Mutagenesis Branch
P.O. Box 12233
Research Triangle Park, North Carolina 27709

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EPA/ERDA - Development of Permanent Epithelial Cell Lines

$ 60,000

Objectives are: (1) to develop the means by which chemicals associated with non-nuclear energy generation, especially agents arising from coal and oil shale extraction, can be screened for potential carcinogenic activity reliably, quickly and cheaply relative to current animal exposure techniques; and (2) to utilize appropriate cultured cells developed in (1) for the study of hydrocarbon carcinogen metabolism to active forms and the mechamism of chemical carcinogenesis. A research group with two discrete but closely related approaches to these problems is being developed. These are: (1) Cell Biology - The major focus here will be the development of permanent cell lines of epithelial origin (human, when possible and appropriate) which posses the enzymatic equipment for carcinogen activation and which are transformable with high frequency; (2) Biochemistry - Principal focus will be the study of metabolism of polycyclic hydrocarbons in various cell lines developed in approach (1), to establish with certainty the "ultimate" carcinogenic metabolite, using primarily high pressure liquid chromatography techniques.

Dr. George D. Duda - ERDA

Oak Ridge National Laboratory
J. Selkirk, Biology Division
P.O. Box X
Oak Ridge, Tennessee 37830

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EPA/ERDA - Detection of Early Changes in Lung Cell Cytology by Flow Systems Analysis Techniques

$ 50,000

The objective of this health effects program is the application of modern automated cytology techniques for

assessment of damage to human populations resulting from exposure to physical and chemical agents associated with oil shale and coal extraction, conversion, and utilization. The approach is to apply unique flow-system cell-analysis and sorting technologies developed at the Los Alamos Scientific Laboratory to determine cytological and biochemical indicators of early atypical changes in exposed lung epithelium using the Syrian hamster initially as a model test system. The current plans are to adapt cell preparation and staining methods developed for flow systems to characterize lung cells from normal and exposed hamsters using the multiparameter cell separator and multiangle light-scatter systems. This includes acquisition of respiratory cells by lavaging the lungs with saline, adapting cytological techniques developed on human gynecological specimens to hamster lung epithelium for obtaining single-cell suspensions, utilization of existing staining techniques for measurement of cellular biochemical properties, and initial characterization of lung cells using flow analysis instrumentation. Progress has been achieved in measuring DNA content, total protein, esterase activity, cell size, nuclear and cytoplasmic diameters, and multiangle light-scatter properties of exfoliated hamster lung cell samples composed of macrophages, leukocytes, epithelial, and columnar cells. As this new technology is adapted further to analyze lung cells from hamsters and subsequent characterization studies are completed, measurement of changes in physical and biochemical cell properties as a function of exposure to toxic agents associated with synthetic fuels energy production will be performed, with eventual examination of sputum samples from occupationally exposed humans.

Dr. George D. Duda - ERDA

Los Alamos Scientific Laboratory
University of California
J. A. Steinkamp, Health Division (MS881)
Los Alamos, New Mexico 87545

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EPA/ERDA - Somatic Cell Genetics

$100,000 The genetics program is currently isolating temperature sensitive (ts) mutants (variants) of the mammalian cell lines CHO and DON CCL for use in studying the genetics of cell life-cycle traverse. In addition to these ts mutants, several auxotrophic clones have been isolated and the NGPRT+ → HGPRT⁻ mutation system has been developed for use in assessing the mutagenicity of suspected car-

cinogens derived primarily from coal gasification and shale extraction processes. The Ames Salmonella/microsome test system will serve as an ancilliary test for mutagenicity. The mammalian cell forward and reverse mutation system and the Ames bacterial test system are currently functional in this laboratory. Temperature-sensitive life-cycle traverse mutants are being analyzed to determine in what phase of the life cycle the ts phenotype is expressed using the LASL flow microfluorometer (FMF II). This is a two year program ending in 1977.

Dr. George D. Duda - ERDA

Los Alamos Scientific Laboratory
University of California
B. J. Barnhart, Cellular and Molecular Biology Group
P.O. Box 1663
Los Alamos, New Mexico 87545

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EPA/ERDA - Analysis of the Effects of Energy-Related Toxic Materials to Karyotype Stability in Mammalian Cells

$ 50,000

The objectives of this program are to develop systems for the rapid detection of karyotypic changes in mammalian cells as a result of exposure to energy-related environmental pollutants and to screen selected subjects utilizing these systems. Flow microfluorometry (FMF) of isolated, fluorescently stained chromosomes will be used to identify chromosome aberrations, and FMF of stained intact cells will be used to detect mitotic nondisjunction. Cadmium will be used as the clastogenic agent in the development of a test system. It has been demonstrated that chromosome analysis can be accomplished by flow systems in mammalian cells with relatively simple karyotypes (Chinese hamster 2N = 22). Cadmium at low concentrations (2×10^{-6} M) is a potent clastogen. It induces primarily chromatid-type aberrations. We have also demonstrated that tolerance to the damaging effects of cadmium can be induced in fibroblast cells in culture by long-term exposure of the cells to sublethal concentrations (2×10^{-7} M) of cadmium. Repeats of these experiments are planned on human fibroblast and lymphocyte cells in vitro and to extend these studies to other toxic agents associated with alternative energy technologies.

Dr. George D. Duda - ERDA

Los Alamos Scientific Laboratory
University of California

L. L. Deaven, Health Division (MS881)
Los Alamos, New Mexico 87545

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EPA/ERDA - Development of Cytochemical Markers for Cell Transformation and Carcinogenesis

$325,000

The objective of this project is to develop rapid, sensitive, and economical systems for the in vitro and cytological assay for carcinogenic effects of substances involved in the extraction conversion and utilization of nonnuclear energy sources, with particular consideration of in situ coal gasification, shale oil utilization, coal-burning power plants, and geothermal power plants. The approach is based on the development of cytochemical markers for cell transformation, and on the ability to quantitate such markers by microfluorometry and by flow system analysis and sorting. There are two phases to this work: (1) the development of appropriate test systems whose response is defined by well characterized and representative carcinogenic agents, and (2) the application of such systems to substances released by energy technologies, and including testing with whole and fractionated samples of effluents. The intracellular levels of several hydrolytic enzymes have been chosen as potential early indicators of cell transformation. Using synthetic fluorogenic enzyme substrates, the levels of four proteases and five esterases have been measured on monolayer cultures of Chinese hamster ovary cells, Syrian hamster embryo cells and human lung fibroblasts (both normal and viral transformed). Hydrolase profiles generated from these measurements indicate signficant differences between cell types. Flow cytometry analysis on W138 cells (normal versus SV-40 transformed) indicates that intracellular Cathepsin B1 and Alkaline Phosphatase levels can be used to distinguish individual normal cells from transformed cells. These same enzyme assays will be used to determine an optimum in vitro system for subsequent carcinogen treatment and flow analysis. Project duration is from June, 1975, to June, 1980.

Dr. George D. Duda - ERDA

Lawrence Livermore Laboratory
B. H. Mayall, Biomedical and Environmental Research Division
P.O. Box 808
Livermore, California 94550
(415) 447-1100 X3587

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EPA/ERDA - Mutagenicity Assay of Fractionated Coal Conversion Products

$125,000

Using rapid screening genetic assays (Ames System), the objective is attempting to identify mutagenic agents associated with coal and oil shale extraction, conversion or utilization. Primary and subfractions of products and aqueous discharges are being assayed for the ability to inactivate and/or revert histidine requiring mutants of Salmonella. Potential mutagenic fractions will be identified and attempts will be made to ascertain the specific compound(s) responsible for the mutagenic action. Parallel bioassays are being carried out with selected materials in yeast, Drosophilia, and human leucocytes. Thus, the validity of short-term testing for genetic damage will be ascertained. The preliminary fractionations have been carried out and the genetic assays are in progress. These investigations are the initial attempts to monitor environmentally important processes for genetic damage. The value of short-term testing as a pre-screen for carcinogenesis of environmental effluents is being considered.

Dr. George E. Stapleton - ERDA

ERDA, Oak Ridge National Laboratory
J. L. Epler, Biology Division
P.O. Box X
Oak Ridge, Tennessee 37803

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EPA/ERDA - In Vivo Screening for Gene Mutation in Mouse Germ and Somatic Cells

$175,000

In screening for mutagenic agents it is important to includemammalian tests for gene mutations. In this project, identification of mutagens associated with coal and oil shale technologies that can induce gene mutations and small deficiencies will be accomplished by scoring for (1) transmitted specific-locus mutations induced in germ cells and (2) somatic mutations in coat color genes. The specific-locus method developed has been employed extensively in radiation work and has already proved its usefulness in chemical mutagenesis studies. It is the only established, reliable and definitive test for transmitted gene mutations and small deficiencies currently available in mammals. Two polycyclic hydrocarbons that might be a human hazard as the result of coal liquefaction and gasification processes, namely, benzo [a] pyrene and 7,12-dimethylbenz [a] anthracene, are not being tested. In order to make the method economically efficient for

screening purposes, it will be used to test whether there is anything mutagenic in a whole mixture of compounds, for example, in an effluent. One mixture from a coal conversion process that has just become available after studies with nonmammalian systems is now being used in preliminary toxicity tests. An in vivo somatic-mutation method, developed in an earlier X-ray experiment, has now been explored for its usefulness in the prescreening for germinal point mutations induced by chemicals. In an array of seven compounds tested, parallellism with spermatogonial specific-locus mutation rates was found, indicating that the in vivo somatic-mutation test may detect point mutations in addition to other types of genetic changes that lead to expression of the recessive. The method is now being used to test fractions from coal-conversion processes.

Dr. George E. Stapleton - ERDA

ERDA, Oak Ridge National Laboratory
W. L. Russell, L. B. Russell
P.O. Box X
Oak Ridge, Tennessee 37830

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EPA/ERDA - Development of An In Vitro Assay for Co-Carcinogenesis of Coal/Oil Shale Derivatives

$ 50,000

The object of this investigation is to develop an in vitro assay capable of detecting the co-carcinogenic potential (with X-rays) of materials produced during coal and oil shale processing. Initially it was proposed to utilize mouse tissue cultured cells and an already established transformation assay. Initial experiments indicated that rodent cells may process lesions induced by alkylating agents different from human cells and that therefore their use as screening materials might be misleading. This was shown by demonstrating that a variety of DNA damaging agents yielded significantly different effects on various cell lines when measured by a variety of techniques. It was hypothesized that a ventral difference between the lines (rodent versus human) may be the "activation of oncogenesis" related to the strand breakage induced, rodent lines carrying transforming virus materials of a complete or incomplete nature, which is lacking in most human targets cells. This is being evaluated through cell hybridization analysis using hybrids made by sendaivirus fusion of cells lacking either (a) different DNA repair enzymes or (b) (potential) RNA viruses.

Dr. George E. Stapleton - ERDA

UCLA School of Medicine
John E. Byfield
Department of Radiology (UCSD)
900 Veteran Avenue
Los Angeles, California 90024

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EPA/ERDA - Effects of Agents Associated with Coal and Oil Shale Extraction, Conversion, or Utilization on Cell-Cycle Kinetics and on Chromatin/Chromosome Structure

$ 50,000

It is essential that ERDA/EPA provide a means for detecting and monitoring damage to human populations as a result of exposure to various toxic chemical and physical agents. To obtain an idea of the parameters to be monitored in humans, it is necessary first to establish the effects of agents on cells in simpler model systems. Earlier experience with drugs which act as carcinogens and teratogens has convinced researchers that changes in population cell-cycle distribution and alterations in chromatin structure may provide useful early indicators of sublethal damage to cells exposed to hazardous agents. Examination will be made of alterations in these parameters following exposure to specific energy-related toxic substances in currently available tissue-culture systems which show promise as a predictive indicator of response of human populations. A technique has been developed that allows preparation of both cycling and noncycling cell populations in tissue culture, mimicking these classes of somatic cells in humans. By combining autoradiography, cell number enumeration, and flow microfluorometry, it will be possible to obtain highly detailed information regarding the cellular kinetic response of both arrested and cycling populations to treatment with toxic agents. Results obtained to date suggest that DNA-interactive agents elicit different types of kinetic responses in treated cells, indicating a degree of specificity of interaction between various alkylating and intercalating agents and the genome.

Dr. George E. Stapleton - ERDA

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Robert A. Tobey, Health Division (MS881)
Los Alamos, New Mexico 87545

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EPA/ERDA - Morphological Variants in Damaged Sperm

$ 60,000

Ionizing radiation as well as various mutagens, carcinogens and teratogens are known to induce elevated levels of morphologically abnormal sperm in mice. The objectives of this study are: (1) to further develop and apply the detection of morphologically abnormal mouse sperm as a rapid, simple quantitative assay of the pathologic response of the male gonad to toxic agents; (2) to extend the studies in the mouse to the hamster; and (3) to develop the methodology of automated scoring of abnormally shaped sperm, especially after the exposure of the male to toxic agents. Of special interest are possible effects of the chemical pollutants associated with the recovery, process stream, and emission of nonnuclear sources of energy, especially coal gasification and oil shale extraction in situ. To accomplish these objectives, groups of test mice have received subacute or chronic exposures by injection, inhalation, or dermal application as is appropriate. The percent of abnormally shaped epididymal sperm will be determined as a function of dosage and time after exposure. These results will be compared to those obtained by more conventional mutagens, carcinogens and teratogens. Preliminary studies with the hamster and mouse have shown that these two species are qualitatively very similar in response. Furthermore, an attempt is being made to distinguish sperm morphology in these species based on suggested differences in fluorescent dye uptake. These results may well lead to automated analyses of sperm morphology. Project duration is from June, 1975, to June 1980.

Dr. George E. Stapleton - ERDA

Lawrence Livermore Laboratory
Andrew J. Wyrobek
P.O. Box 808
Livermore, California 94550
(415) 447-1100

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EPA/ERDA - Quantitative Mutagenesis Testing in Mammalian Cellular Systems

$100,000

Objectives of this project are: (1) to develop and apply quantitative multiple-marker assays utilizing cultured mammalian cells for the evaluation of potential mutagenic effects of agents derived from energy technologies; and (2) to use these existing and newly-developed bio-

logical screening systems for the identification of mutagenic agents associated with coal and oil shale extraction, conversion, or utilization. This program proposes the use of multiple drug-resistance markers for forward mutation in cultured Chinese hamster ovary (CHO) cells, as well as in vitro and host-mediated in vivo/ in vitro procedures in the Syrian hamster embryo (SHE) system. The markers being developed measure the frequency of forward mutation at the recessive azaadenine-resistant marker, the X-linked azaguanine-resistant phenotype, and the dominant ouabain-resistant locus. Established procaryote and lower eucaryote systems will be used for comparison and reference; the most satisfactory markers in all systems will then be combined into a standard protocol in which each of the gene loci can be measured for mutation following exposure to a particular test agent or combination thereof. Progress to date has been: (1) Selection and validation of three CHO cell lines heterozygous at the adenine phosphoribosyltransferase locus. These stock lines have been tested for optimal cell plating, selecting drug concentration, and expression time; the cell lines are now being used in triple marker mutagenesis experiments. (2) The SHE system has been tested extensively-plating efficiency optimized, ouabain resistance determined, with work currently in progress to optimize the azaguanine-resistance marker. Both CHO and SHE systems have been tested with the standard mutagen EMS, and experiments utilizing specific hydrocarbons relevant to energy technology are now underway. Project duration is from June, 1975, to June, 1980.

Dr. George E. Stapleton - ERDA

Lawrence Livermore Laboratory
F. T. Hatch, Biomedical Sciences Division
P.O. Box 808
Livermore, California 94550
(415) 447-1100 X3563

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EPA/ERDA - Establishment of a Chemical Repository for Alternate Energy Source Material for Toxicity Testing

$295,000

This project will provide a repository where materials from new energy sources can be received, identified, divided into replicate specimens for testing, and forwarded to participating laboratory for testing with sufficient material being held under appropriate methods of storage for future reference. Materials to be handled include products and combustion effluents from coal

gasification and liquefaction and shale oil extraction. This effort will be combined with a similar effort being undertaken by the NCI. The project duration is from October, 1975, to September, 1978.

David L. Coffin, D.V.M. - EPA, HERL, RTP
(919) 549-8411 X2266

ERDA, Oak Ridge National Laboratory
P.O. Box X
Oak Ridge, Tennessee 37830

****

EPA/ERDA - Effect of Alternate Energy Source Material on Whole Animal Carcinogenesis by Percutaneous Application of Extracts and Fractions to Mice

$100,000 (FY 75)
$190,000 (FY 76A)

This project constitutes the lead laboratory for carcinogenesis for the EPA studies of the toxic effects of products and effluents from alternate energy sources. Materials for study will be derived through the chemical repository. Materials received will be subjected to preliminary toxicity testing and fractionation followed by cancer screening by standard methods, including skin painting and injection. Data from this contract will be used to evaluate data from other methods such as bacterial mutagenesis, neoplastic transformation, intratracheal instillation, etc., in order to arrive at a coherent view of the relative value of various methods in dealing with practicable evaluation of carcinogenesis potential of crude materials or portions. Project duration is from September, 1976, to September, 1978.

David L. Coffin, D.V.M. - EPA, HERL, RTP
(919) 549-8411 X2266

ERDA, Oak Ridge National Laboratory
Robert Wood
Oak Ridge, Tennessee 37830

****

ERDA - Interactions Between Damage (and Repair of Damage) Resulting from Hazardous Agents Associated with Coal and Oil Shale Technologies and Ultraviolet Damage

$163,000

Effects of ultraviolet radiation and chemical agents from coal and oil shale technologies on the repair of damage of cells. Completion date: July, 1977.

R. A. Jensen - ERDA

Brookhaven National Laboratory
Biology Department
Upton, New York

****

ERDA - Regulatory Processes in Damaged Cells

$ 80,000 Study cell regulatory systems as effected by hazardous agents associated with coal and oil shale technologies. Completion date: July, 1977.

R. A. Jensen - ERDA

Oak Ridge National Laboratory
Biology Division
Oak Ridge, Tennessee 37830

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ERDA - Molecular Damage of DNA and Proteins Caused by Hazardous Metals, Metal Ions and Organic Compounds Associated with Coal and Oil Shale Technologies

$ 50,000 Interactions of nucleic acids, proteins, etc., with hazardous substances related to coal and shale oil technologies. Completion date: July, 1977.

R. A. Jensen - ERDA

University of California at Los Angeles
Los Angeles, California 90024

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ERDA - Processes by which Laboratory Mammals Recover from Damage by Exposure to Pollutants Associated with Coal Gasification and Shale Distillation.

$ 90,000 Health implications for people exposed to quantites of potentially hazardous materials. Emphasis will be on the sequence of events occurring in the immune system. Completion date: January 1, 1978.

M. L. Minthorn - ERDA

Los Alamos Scientific Laboratory
Health Division, Mammalian Biology Group
Los Alamos, New Mexico

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NIOSH - Mortality and Morbidity Among Oil Shale Workers

$160,000 Mortality due to 21 specific causes of approximately 230 persons who worked at a pilot oil shale operation in Rifle, Colorado, will be studied. Completion date: June, 1977.

John F. Finklea - NIOSH

NIOSH, Western Area Occupational Health Laboratory
Salt Lake City, Utah

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NIOSH - Enumeration of Energy Occupational Health Problems

$ 80,000 Identify occupational health problems associated with the extraction, processing, etc., of energy resources. Completion date: May, 1980.

John F. Finklea - NIOSH

NIOSH, Western Area Occupational Health Laboratory
Salt Lake City, Utah

****

In addition to government-funded research in the area of health effects, the American Petroleum Institute (API) has been investigating medical and biological effects under the direction of Neill K. Weaver, M.D. The funding levels shown are for calendar year 1976.

API - Environmental Impact of Emissions and Effluents from Shale Oil Processes

$ 30,000 To evaluate the impact of effluents and emissions from processing of these alternate energy sources on the non-human biota of the area. There may be related hazards not identified or recognized in this program. This project involves a review of selected literature, limited plant visits, and preparation of an annotated listing of additional health and environmental matters to be considered by API.

Neill K. Weaver, M.D. - API

API, Department of Medicine and Biological Science
2101 L Street NW
Washington, D. C. 20027
(202) 457-7190

****

API - Analytical Support for Program on Toxicity of Shale Oil Products

$ 75,000 To characterize selected samples of shale oil products studied in the toxicity program. The following determinations will be made: PONA (paraffins-olefins-naphthenes-aromatics) content, trace metals, PNA (polynuclear aromatic hydrocarbons) by GC/UV/MS silica content, asbestos, radio-activity. In addition, certain other specialized tests (heterocyclics, carbon number distribution, etc.) may be required on some samples.

Neill K. Weaver, M.D. - API

API, Department of Medicine and Biological Science
2101 L Street NW
Washington, D. C. 20027
(202) 457-7190

****

API - Chronic Inhalation Toxicity of Shale Oil Process Products

$250,000 To determine the chronic inhalation toxicity of shale oil process products by exposing experimental animals under appropriate laboratory conditions. Standardized procedures appropriate for occupational and environmental health evaluation and acceptable to regulatory agencies will be employed.

Neill K. Weaver, M.D. - API

API, Department of Medicine and Biological Science
2101 L Street NW
Washington, D. C. 20027
(202) 457-7190

****

API - Carcinogenic Potential of Shale Oil Products

$ 45,000 To determine the potential for carcinogenic activity by shale oil products. Standardized procedures appropriate for occupational and environmental health evaluation and acceptable to regulatory agencies will be employed.

Neill K. Weaver, M.D. - API

API, Department of Medicine and Biological Science
2101 L Street NW
Washington, D. C. 20037
(202) 457-7190

****

API - Sensitization Potential of Shale Oil Products

$ 10,000 To determine if there is a potential for sensitization (allergic contact dermatitis and photosensitization) through contact with shale oil products. Human patch test techniques will be employed. Standardized procedures appropriate for occupational and environmental health evaluation and acceptable to regulatory agencies will be employed.

Neill K. Weaver, M.D. - API

API - Department of Medicine and Biological Science
2101 L Street NW
Washington, D. C. 20037
(202) 457-7190

****

API - Acute and Subacute Toxicity and Mutagenic Potential of Shale Oil Products

$200,000 To assess the acute and subacute toxicity and mutagenic potential of shale oil products through exposure of experimental animals by various routes including oral, dermal, eye, and inhalation. Standardization procedures appropriate for occupational and environmental health evaluation and acceptable to regulatory agencies will be employed.

Neill K. Weaver, M.D. - API

API - Department of Medicine and Biological Science
2101 L Street NW
Washington, D. C. 20037
(202) 457-7190

****

API - Medical Surveillance Procedures for Shale Oil Operations

$ 25,000 To develop medical surveillance procedures. It is important to preplan the type of medical data to be collected so that consistent, industry-wide statistics are available and that epidemiological studies of the prospective type may be conducted. A currently sponsored program (Medical Records Systems) will contribute technical approaches to portions of this project.

Neill K. Weaver, M.D. - API

API - Department of Medicine and Biological Science
2101 L Street NW
Washington, D. C. 20037
(202) 457-7190

****

API - Hazards of Major Shale Oil Processes and Their Control

$25,000

To identify hazards associated with major processes and develop protocols for their control. The principal needs in this area are for early identification of unit operations which may involve health risks from exposures to crude or processed materials and the recommendation of industry-wide protocols for plant surveys. API is presently sponsoring a project for the identification of hazards for conventional petroleum operations (Refinery Monitoring Manual). Another project (Evaluation and Control of Potential Environmental Hazards in the Petroleum Industry) addresses the development of protocols for control. These two projects will serve as bases for this project.

Neill K. Weaver, M.D. - API

API, Department of Medicine and Biological Science
2101 L Street NW
Washington, D. C. 20037
(202) 457-7190

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VII. MISCELLANEOUS OIL SHALE RESEARCH

This section addresses research that is not aimed primarily at environmental considerations. Such research includes socio-economic studies, resource and process development, and oil shale characteristics and properties. The government funding level cited is $19,579,108.

EPA/USDA - Integrated Assessment: Socio-Economic Consequences of Coal and Oil Shale Development

$396,000

The objectives of this project are to describe current resource use in coal and oil shale extraction and to assess agricultural economic implications, resource competition and use resulting from alternative future coal and oil shale development. This work will also estimate the impact energy development in Northern Great Plains on employment, income, and population of rural communities and on local government finances and services, including revenue potential. Interrelationships of local government expenditures to employment, population, income, age structure, and other socio-economic variables will be analyzed. The work will evaluate costs of mined land reclamation and uses for land after mining. Interregional economic implications and trade-offs for agricultural and rural areas resulting from coal development will also be evaluated. Included are effects of increased water demand for coal development on agricultural industries, environmental quality and rural resource use. The duration of this project is from March, 1976, to June, 1979.

John R. Schaub - USDA, Washington, D.C.

USDA, Economic Research Service
V. Davis, Natural Resource Economics Division
12th and Independence Avenue, SW
Washington, D.C. 20250
(202) 447-8104

****

ERDA - Conversion of Shale Oil to Fuel Products

$230,000*

Objectives of this study are to develop improved methods for producing liquid and gaseous fuels from shale oils. One phase of the project is directed toward reducing sulfur, nitrogen, and oxygen contents of the produced oils. A second phase of the work is directed toward producing pipeline quality gas from an in situ operation.
*FY72 - FY77

ERDA, Fossil Energy Program
Division of Oil, Gas, and Shale Technology
Washington, D.C.

ERDA, Laramie Energy Research Center
Laramie, Wyoming

****

ERDA - Refining Process Technology

$ 87,000 Objectives of this project are to determine the refining characteristics of syncrudes and to establish the overall refining process as needed to satisfy future energy patterns.

ERDA, Fossil Energy Program
Division of Oil, Gas, and Shale Technology
Washington, D.C.

ERDA, Bartlesville Energy Research Center
Bartlesville, Oklahoma

****

ERDA - Observation of Industry Program at Anvil Points Facility

$108,000 Provide operating funds to support the Paraho project at Anvil Points, Colorado. The Office of Naval Research has continued funding for a 100,000-barrel test run.

ERDA, Fossil Energy Program
Division of Oil, Gas, and Shale Technology
Washington, D.C.

ERDA, Laramie Energy Research Center
Laramie, Wyoming

****

ERDA - Massive Hydraulic Fracture, Mapping, and Characterization Program

$1,675,000 Demonstrate techniques necessary to define the orientation and dimensions of massive hydraulically induced fractures. Future work will involve a Devonian shale site.

ERDA, Fossil Energy Program
Division of Oil, Gas, and Shale Technology
Washington, D.C.

ERDA, Laramie Energy Research Center
Laramie, Wyoming

****

ERDA - Determine the Potential Gas Reserves in the Devonian Shale

$487,593* To thoroughly characterize the shale, and to evaluate and improve state-of-the-art exploration and extraction technology. *Cost-sharing contract with AMEX/VESCORP. Estimated cost to ERDA is $487,593 for the five-year project.

AMEX/VESCORP Industries, Inc.
Worthington, Ohio

****

ERDA - Gasification of Oil Shale

$165,000 Objectives of this program are to define the operating parameters of oil shale retorting such that the off-gas produced has a sufficient Btu content to be directly usable in the turbine, to study the feasibility of producing pipeline quality gas by gasification of oil shale, and to study means of recovering the maximum energy from oil shale. Studies have been performed on the 150-ton retort to provide the answers for the scope of work. Off-gas heat content has ranged from 40 to 90 Btu/standard cubic feet. Hydrocarbon recovery was shown to be 84 percent of the organic material originally present in the shale.

ERDA, Fossil Energy Program
Division of Oil, Gas, and Shale Technology
Washington, D.C.

ERDA, Laramie Energy Research Laboratory
Laramie, Wyoming

****

ERDA - Refining and Upgrading of Synfuels from Coal and Oil Shale by Advanced Catalytic Processes

$1,588,598 Chevron Research Co.
Richmond, California

****

ERDA - Develop and Demonstrate an In Situ Process for Extraction of Energy from Devonian Shale

Bruce Sudit - ERDA, Laramie Energy Research Laboratory

Dow Chemical Co.

****

ERDA - In Situ Processing Supporting Process Development

$2,000,000* Engineering variables are being studied to develop an in situ process.
*Approximate funding from FY65 to present.

ERDA
Fossil Energy Program
Division of Oil, Gas, and Shale Technology
Washington, D.C.

ERDA, Sandia Laboratories
Albuquerque, New Mexico

****

ERDA - Impact of Legal and Regulatory Policies on the Commercialization of Oil Shale

Project is to identify the regulatory constraints and other legal policy issues which would constrain commercialization of oil shale development in Colorado and Utah. Final report is due spring, 1977.

Massachusetts Institute of Technology
Dr. Larry Linden, Energy Laboratory
Cambridge, Massachusetts 02139
(617) 253-3400

****

ERDA - Develop a Methodology for Cost/Risk/Benefit Trade off Analysis of Nuclear, Oil Shale, Geothermal, and Coal Use for Power Production in the Western States

$100,000 Western states energy development balanced benefits.
Completion date: April, 1976.

Jerry Olson - ERDA

ERDA, Los Alamos Scientific Laboratory
Los Alamos, New Mexico

****

ERDA - Mechanical Properties of Oil Shale

$ 66,000 (FY77) Mechanical properties, including static compressive and tensile strengths are being investigated. These properties will provide some insight into the fracturing mechanisms in an in situ oil shale combustion. Project period of performance is from December 1975 to October 1977.

John Ward Smith - ERDA, LERC
P. O. Box 3395, University Station
Laramie, Wyoming 82071

University of Wyoming
Mr. Ken Chong, Department of Civil Engineering
Laramie, Wyoming 82070

****

ERDA - Massive Hydraulic Fracturing in the Devonian Shale

More than $2,000,000

Assess the technical and economic effectiveness of massive hydraulic fracturing techniques for the development of potentially large gas reserves in the Appalachian Basin Devonian shale.

ERDA, Division of Oil, Gas, and Shale Technology, Washington, D.C.

Columbia Gas System Service Corp.

****

ERDA - The Real Cost of Alternative Energy Resources

$ 49,981

Massachusetts Institute of Technology
Cambridge, Massachusetts 02139
(617) 253-3400

****

ERDA - Electrical and Thermal Conductivities of Green River Oil Shale

$ 24,667

Thermal properties and electrical properties of oil shale are being defined. Project period was June 1, 1975, to March 1, 1976. Research is now funded by NSF.

ERDA, Fossil Energy Program, Division of Oil, Gas, and Shale Technology, Washington, D.C.

Colorado State University
Fort Collins, Colorado 80521

****

ERDA - Characteristics of Oil Shales

$314,000 (FY75)

ERDA, Fossil Energy Program
Division of Oil, Gas, and Shale Technology
Washington, D.C.

ERDA, Laramie Energy Research Center
Laramie, Wyoming

****

ERDA - In Situ Bed Preparation Study, Advanced Instrumentation, Rock Mechanics, and Diagnostics Support for LERC Program

$1,100,000 A part of the Sandia FY76 program.

ERDA, Sandia Laboratories
Albuquerque, New Mexico

****

ERDA - Explosively Produced Fracturable Oil Shale

$300,000 (FY76) Los Alamos Scientific Laboratory
Los Alamos, New Mexico

****

ERDA - Accelerated Oil Shale In Situ Research - A Joint Government-Industry Program

Negotiations are currently underway with Tally Frac, Geokinetics, Equity Oil Co., and Occidental.

Andy Decora - ERDA, Laramie Energy Research Laboratory

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USBM - Piceance Creek Basin Shaft

$3,635,943 Three contracts have been let for a 2,350-foot deep, eight-foot inside diameter shaft to be drilled into the deep, rich oil shales of the Piceance Creek basin of northwest Colorado. The driller is Rowan Co., Inc. The casing for the shaft will be supplied by Marathon-LeTourneau. Hughes Tool Co. will supply two 500-ton elevators for the shaft. The bore, which is part of a long-range USBM program to develop deep mining techniques in oil shale, has two purposes. Initially, it will provide access for mining of a 500-ton bulk sample of dawsonite-rich shale for testing in the USBM alumina program at the Boulder City, Nevada, laboratory. Subsequently, the shaft may become a ventilation shaft for an experimental deep mine. The bore hole is expected to be completed in the summer of 1977.

Mr. Freedman - USBM (202) 634-1008

Rowan Co., Inc. ($1,639,720.88)
Houston, Texas

Marathon-LeTourneau ($1,852,587.61)
Longview, Texas

Hughes Tool Co. ($143,635.48)
Houston, Texas

****

USBM - Design, Layout, and Costing of a Prototype Underground Demonstration Mine in Oil Shale

$262,632 This project involves design layout and cost assessments of a proposed experimental oil shale mine and is associated with a shaft-sinking project where an eight-foot diameter bore hole is being dug.

Mr. Freedman - USBM (202) 634-1008

Cleveland Cliffs Iron Co.
Cleveland, Ohio, and Rifle, Colorado

****

USBM - Large Diesel Testing for Oil Shale

$153,000 Southwest Research Institute
San Antonio, Texas

****

USBM - Study Contract to Develop Cost-Estimating Procedures to Provide a Cost Analysis Production of Syncrude from Shale

$135,370 A. A. Mathews, Inc.
Arcadia, California

****

USBM - Alumina Process Feasibility Study and Preliminary Pilot Plant Design

$1,581,671 Kaiser Engineers
Oakland, California 94666

****

USBM - Permeability Tests and Coring for Engineering and Environmental Study of Retorted Oil Shale Handling and Disposal

$ 38,146 Development Engineering, Inc.
Grand Junction, Colorado

****

USBM - Evaluation of the Oil Shale Research and Development Program

$ 82,925 Aerospace Corp.
P. O. Box 92956
Los Angeles, California

****

USAF - Evaluation of Methods to Produce Aviation Turbine Fuels from Synthetic Crude Oils

$ 97,276 This program will be conducted in three phases. The objective of Phase I is to determine which raw materials and processes will provide refinery feedstocks most amenable to production of finished aviation turbine fuel. Raw materials will include coal and oil shale. The objective of Phase II is to provide an experimental base in support of production of aviation turbine fuel from synthetic crude oil. Phase III will provide an overall assessment of material, equipment, and processing requirements for producing the high yields of aviation turbine fuels from coal and oil shale. Phase I consists of an engineering analysis and includes a literature survey. Raw materials, processes, synthetic crude oils, and refinery feedstocks will be selected for further study in the later phases. Phase II is limited to laboratory bench scale experimentation as pilot plant work is not within the scope of this program. Under Phase III requirements unique to production of aviation turbine fuels to production of other liquid products (gasoline, heating fuels, etc.) will be identified.

USAF, Aero-Propulsion Laboratory
Wright-Patterson AFB, Ohio 45433

Exxon Research and Engineering
H. Shaw
P. O. Box 8
Linden, New Jersey 07036

****

USN - Refurbishment, Modification, and/or Replacement of Equipment Comprising "Oil-from-Shale" Experimental Facility at Anvil Points, Colorado

$411,187 Dick Martell - Office of Naval Research, Anvil Points, Colorado

Development Engineering, Inc.
Grand Junction, Colorado

****

USN - Support of a 100,000 Barrel Oil Shale Research and Development Project

$502,129 Mine preparation, precommissioning, and initial startup. Contract was awarded October 29, 1976.

Office of Naval Research

Development Engineering, Inc.
Grand Junction, Colorado

****

USN - Support of a 100,000 Barrel Oil Shale Research and Development Project

$309,621 Install 60,000 barrels of crude shale oil storage at the oil shale research facility located on the Naval Oil Shale Reserve near Rifle, Colorado. Contract was awarded October 29, 1976.

Office of Naval Research

Development Engineering, Inc.
Grand Junction, Colorado

****

USN - Support of a 100,000 Barrel Oil Shale Research and Development Project

$831,032 Initiate shale oil production and conduct research and development on shale retorting technology at Anvil Points, Colorado. Contract was awarded October 29, 1976.

Office of Naval Research

Development Engineering, Inc.
Grand Junction, Colorado

****

NASA - Synthesis and Analysis of Jet Fuels from Shale Oil and Coal Syncrudes

$ 91,230 Contract was awarded July 14, 1975.

NASA, Lewis Research Center

Atlantic Richfield
Harvey Technical Center
Harvey, Illinois

****

NSF - Enhancement of Oil Yields and Residual Carbon Oxidation In Situ Retorting of Oil Shale

$ 84,400 This research is directed to problem areas in the in situ recovery of oil from oil shale. The specific goals are (1) to verify and quantify preliminary findings which indicate that oil yield can be significantly increased by pre-heating large oil shale blocks at low temperatures; (2) to develop a model which describes the overall rate of oxidation of the carbonaceous material in spent shale as a function of the important parameters. It is expected that the results of this research will be valuable in the near term as an aid in the design of experimental in situ retorts. Over the long run, this work will contribute to the overall goal of producing economically viable in situ processes for the recovery of oil from oil shale.

University of Utah
A. L. Tyler, Graduate School
310 Park Building
Salt Lake City, Utah 84112

****

NSF - Assessment of the Generalizability of Socio-Economic Environmental Systems Models

$157,100 The research/utilization team will assemble and build a data base for a test region and use it as the basic core for a test and evaluation center. Such a facility serves the State's needs by: 1) establishing a "proving ground" for the examination of socio-economic environmental models developed in other parts of the country and having potential utility for Colorado; 2) facilitating the development of an interactive process with State officials for delineating State modeling needs and abilities among students, State officials, and others. Present contract expires July 1, 1977.

Colorado Office of State Planning and Budgeting
David E. Monarchi, Management Science Division
Denver, Colorado 80203

****

NSF - Electrical and Thermal Properties of Oil Shale Applied to In Situ Shale Oil Extraction

$145,400 This research project will investigate the thermal and electrical properties of oil shales under conditions which simulate actual field in situ oil shale operations. This research will use simultaneous parameter measurement techniques which utilize automated data acquisition and on-line control of experimental conditions to directly determine oil shale properties. The major tasks to be accomplished during the life of the project are: simultaneous measurement of the thermal conductivity and the electrical impedance (10 Hz to 13 MHz) as a function of temperature (100-1000°F), pressure (0-1000 psi), and kerogen content (10-40 gallons per ton) both parallel and perpendicular to the bedding plane stratifications lines (varves); simultaneous measurement of differential thermal analysis (DTA) and differential dielectric analysis (DDA) as a function of temperature (100-1000°F) and kerogen content (10-40 gallons per ton); rapid, high power, laser flash thermal diffusivity measurement as a function of temperature and kerogen content. Several novel applications suggested by the data will be investigated. These applications include electrothermal fracture of oil shale, heating, in situ thermal impedance characterization, remote thermal diffusivity measurements, electrical determination of the permeability of oil shale beds, and electrical assay of the kerogen content of the oil shales. Recommendations will be made regarding the technical feasibility of these applications. Contract duration is from February, 1976, to June, 1977. An annual report (February 1, 1976 - February 1, 1977) has been published.

Colorado State University
J. B. Dubow, School of Engineering (Electrical)
Fort Collins, Colorado 80521

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FEA - Macroeconomic Impacts of Coal and Oil Shale Development in the Intermountain West

$ 99,955 The contractor will produce a multi-state interregional input-output model which will evaluate the extent and

magnitude of economic growth by sector resulting from alternative levels of coal, oil shale refining, coal gasification, electric power generation, and energy product transmission pipelines in the five-state area of Colorado, Wyoming, Montana, Utah, and New Mexico. Projections through 1985 are to be made in order to evaluate the impacts on future employment, sector output, and industry growth derived from various rates of coal and oil shale development. Impacts on the public sector will also be traced. Side effects from development will also be evaluated, e.g., environmental change, and change in social well-being. Contract duration is from April, 1976, to March, 1977.

Utah State University
C. Lewis, Office of Resource Development
Agricultural Science Building, Room 223A
Logan, Utah 84321

****

FEA - Comprehensive Analysis of Issues Regarding Energy Resource Development on Indian Reservations

$228,452

Ernst and Ernst
1225 Connecticut Avenue NW
Washington, D.C.
(202) 296-8300

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USGS - Stream Sediment Chemistry in the Oil Shale Region

USGS - Geological Division
Mr. John Maberry, Program Manager
Energy Lands Program
MS911, P. O. Box 25046
Lakewood, Colorado 80226
(303) 234-4857

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USGS - Soil Chemistry in the Piceance Creek Basin

USGS - Geological Division
Mr. John Maberry, Program Manager
Energy Lands Program
MS911, P. O. Box 25046
Lakewood, Colorado 80226
(303) 234-4857

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USGS - Geochemistry of Green River Oil Shale

USGS - Geological Division
Mr. John Maberry, Program Manager
Energy Lands Program
MS911, P. O. Box 25046
Lakewood, Colorado 80226
(303) 234-4857

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USGS - Determination of Impacts of Oil Shale In Situ Leasing on Cultural Resources in Colorado and Utah

$ 39,800 Colorado State University
Fort Collins, Colorado 80521

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